ONUS PC GAMER DVD: BEST FREE GAMES

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a·pc

August 2016
Issue 431

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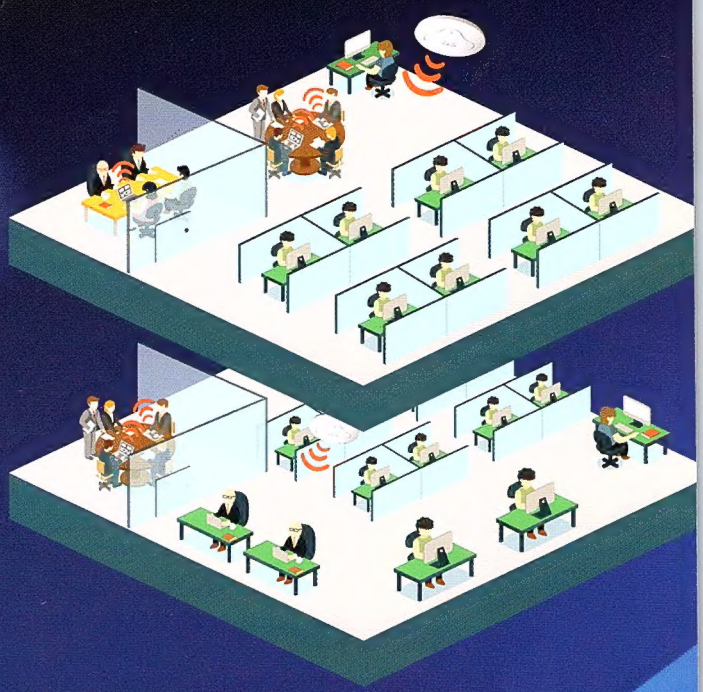

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NBN Ready

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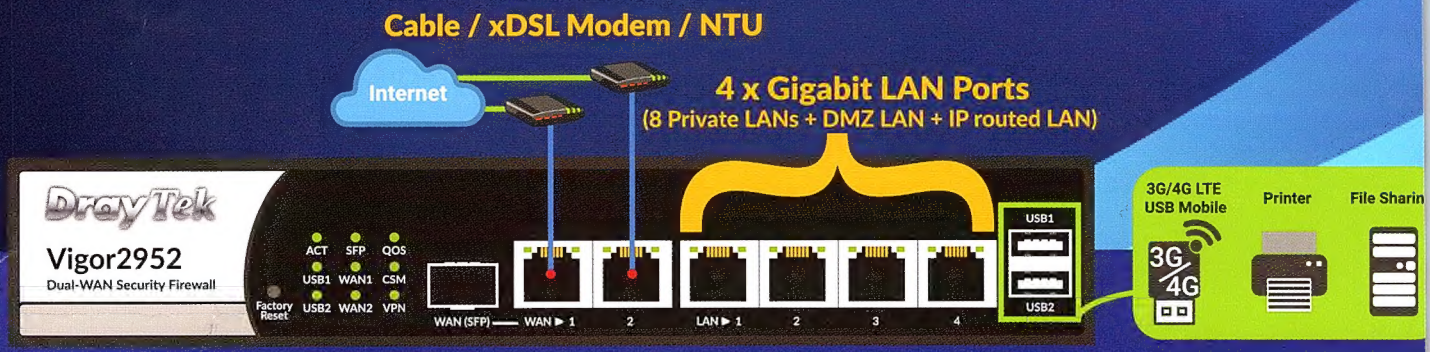

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Future Publishing Australia,
PO Box 1077, Mount Street, North Sydney, NSW 2059
Tel: 02 9955 2677 Fax: 02 9955 2688
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Email: apcmag@futurenet.com
Web: www.apcmag.com

EDITORIAL
Editor-in-Chief **Dan Gardiner**
Sub-Editor / Journalist **Carmel Sealey**
Senior Journalist **Paul Taylor**
Senior Journalist **Shaun Prescott**
Journalist **Joel Burgess**
Journalist **Stephen Lambrechts**

ART/PRODUCTION
Creative Director **Troy Coleman**
Senior Designer **Nykke Coleman**
Designer **Sharnee Brisbourne**

CONTRIBUTORS
Graham Barlow, Helen Bradley, JR Bookwalter, Cat Ellis, Ian Evenden, Ben Griffin, Lindsay Handmer, Kenny Hemphill, Jeremy Laird, Christopher Livingston, Gary Marshall, Nick Peers, Matthew Pellett, Les Pounder, Zak Storey, Nathan Taylor, Alexander Tolstoy, Luis Villazon, Jarred Walton, Tyler Wilde, Darren Yates

SENIOR MANAGEMENT
Chief Operating Officer **Neville Daniels**

COMMERCIAL
Sales Director Paul Marttila
paul.marttila@futurenet.com

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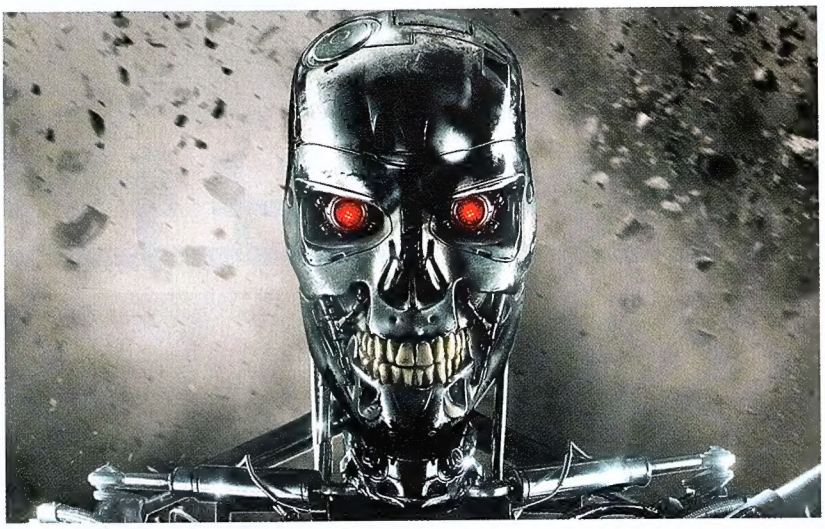

Will AI really doom humanity?

APC's editor Dan Gardiner reckons the fears over a *Terminator*-style apocalypse are much overhyped.

Artificial intelligence (AI) is, once again, one of the hottest topics in tech, with lots of important companies claiming it's the 'next big thing'. But in recent months, we've also seen leaders from the science and tech fields talking about the dangers of AI and why we all need to be wary of its uses.

If you've just read the headlines, it'd be easy to go around waving your hands in the air claiming that the experts are worried about AI and robots rising up and killing us all, *Terminator/Matrix* style. And with names like Stephen Hawking, Elon Musk, Bill Gates and Sir Clive Sinclair behind those headlines, there is perhaps good reason to sit up and take note.

But the truth, as is often the case, is actually far more mundane: all of the above are signees to an open letter seeking to restrict how and where AI is used. And while none of those tech luminaries could really be called AI experts, the letter is actually a lot more sensible than all the hubbub suggests. Sensibly, it wants to curtail the use of AI in weapons development and ensure that AI can't "select and engage targets without human intervention" – they don't want robot soldiers running around with permission to autonomously 'pull the trigger'. Though the signees want humans to remain involved in such weighty decisions – which seems like a reasonable request to me – the letter also states that "we believe that AI has great potential to benefit humanity in many ways".

In a broader sense, self-replicating and self-programming malicious AI, like what we see in pop sci-fi, is still strictly in the fictional realm – we don't know how consciousness works in humans, let alone how we might replicate it in machines. Tech disasters also have a habit of not being nearly as bad as they're hyped to be – anyone that's old enough to remember Y2K will probably also recall that some US tech workers were so convinced that it'd be the end of the world that they turned into doomsday preppers and headed for the hills.

So for now, the AI apocalypse has been cancelled. Or, well, delayed at the very least... ■

DAN GARDINER
EDITOR-IN-CHIEF
dan.gardiner@futurenet.com

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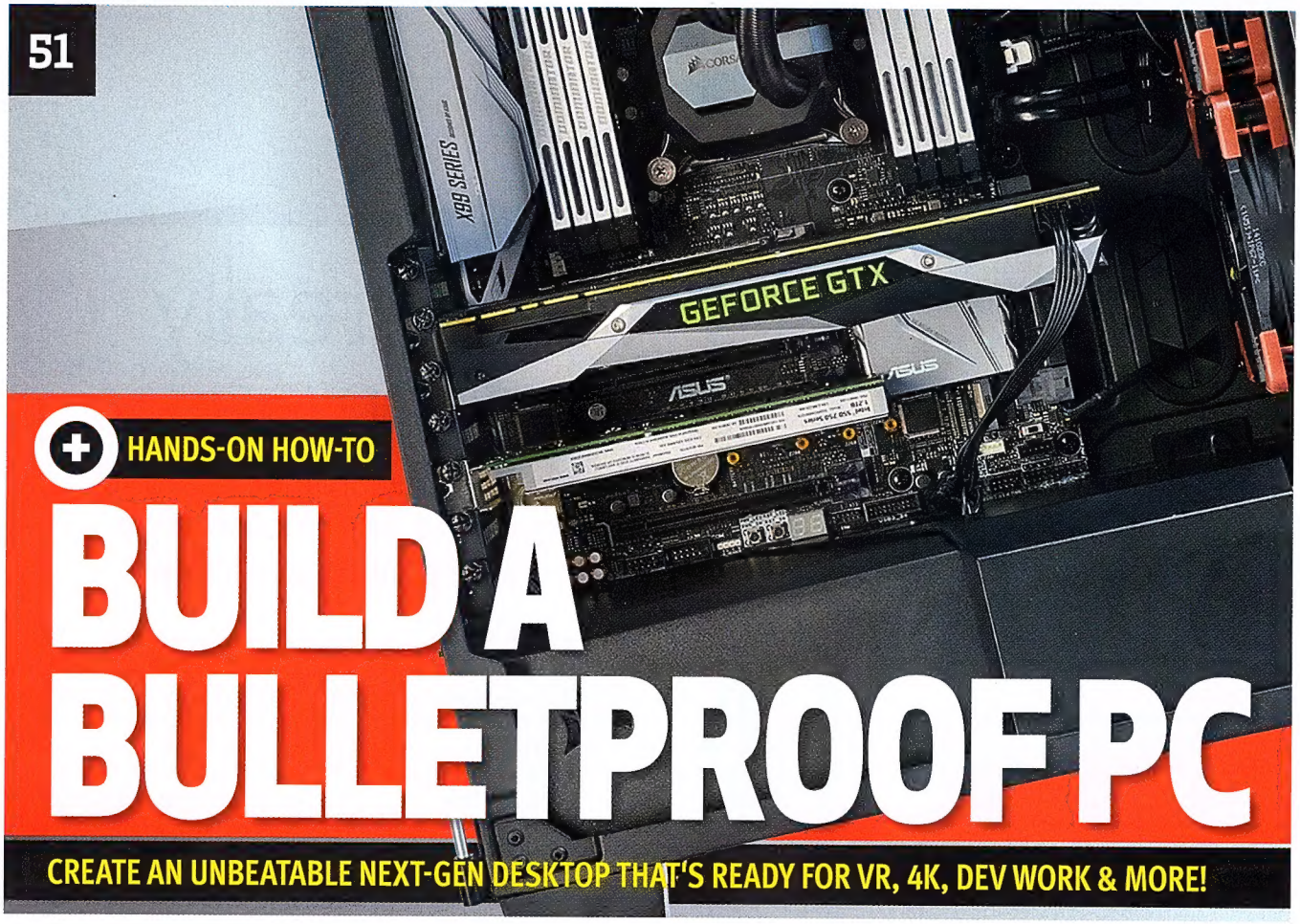

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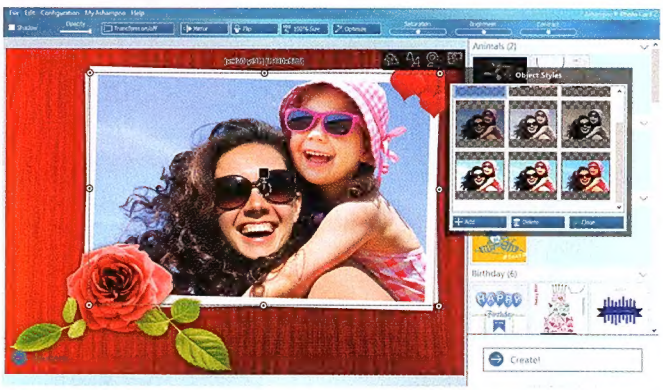

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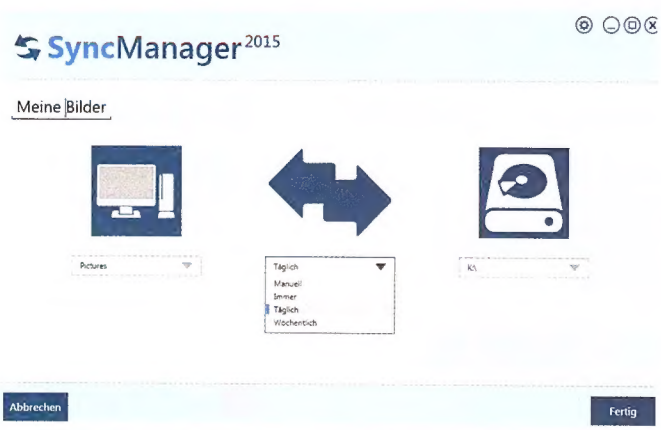

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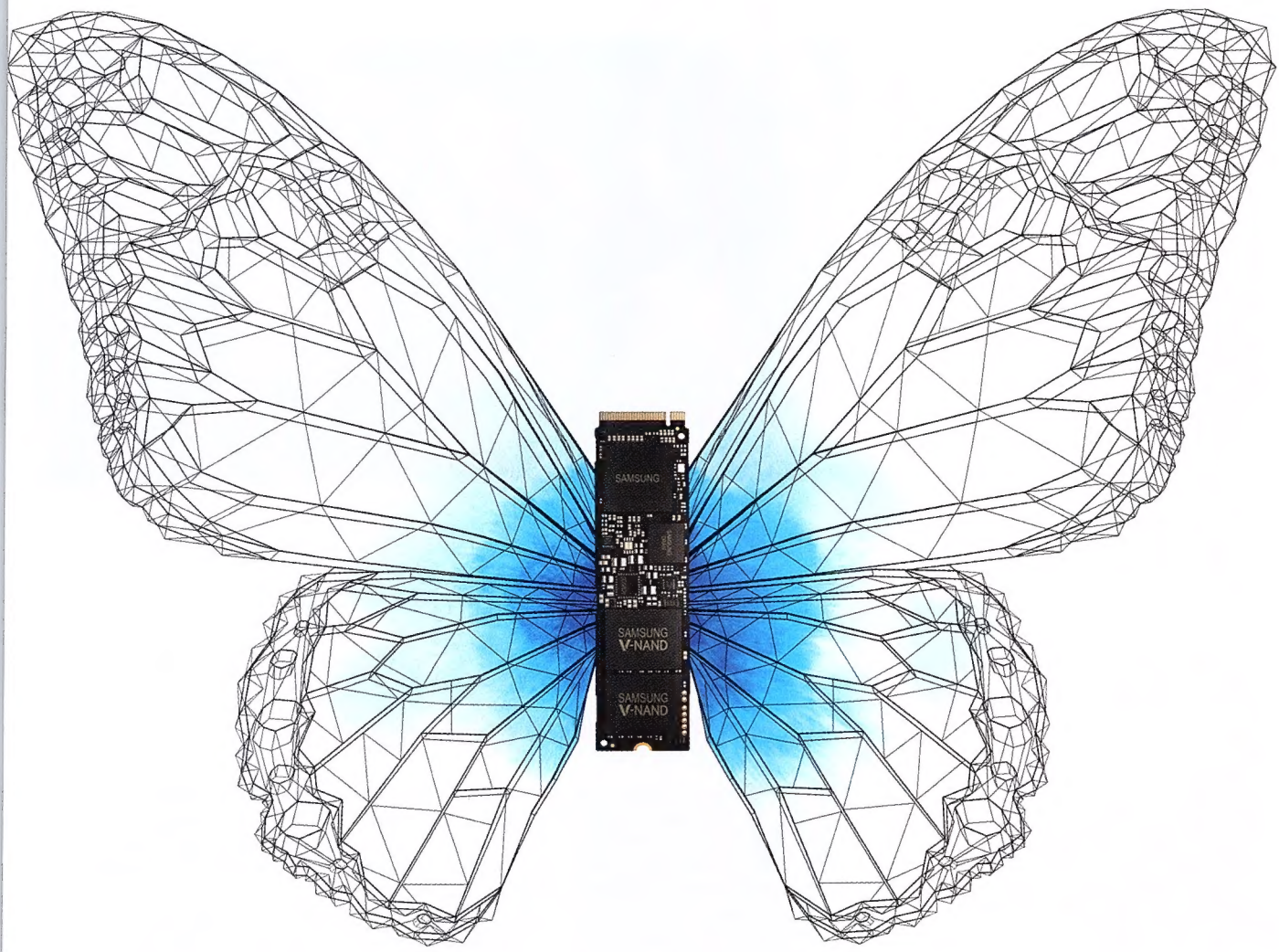

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technotes

» NEED TO KNOW

Cloudian digital billboard targets drivers based on their make of car

PRETTY SOON, WE'LL NEED AD-BLOCKING SOFTWARE FOR OUR BRAINS.

Japan is experimenting with a new form of digital billboard advertising, one that displays targeted ads based on the types of vehicles passing by and the people driving them. Using Cloudian object storage, Quanta Cloud Technology, x86 servers, deep learning software, Amazon Web Services and more, the billboards will select an advertisement and display it for a passing car in less than a second.
SL

Facebook CEO covers his webcam with tape

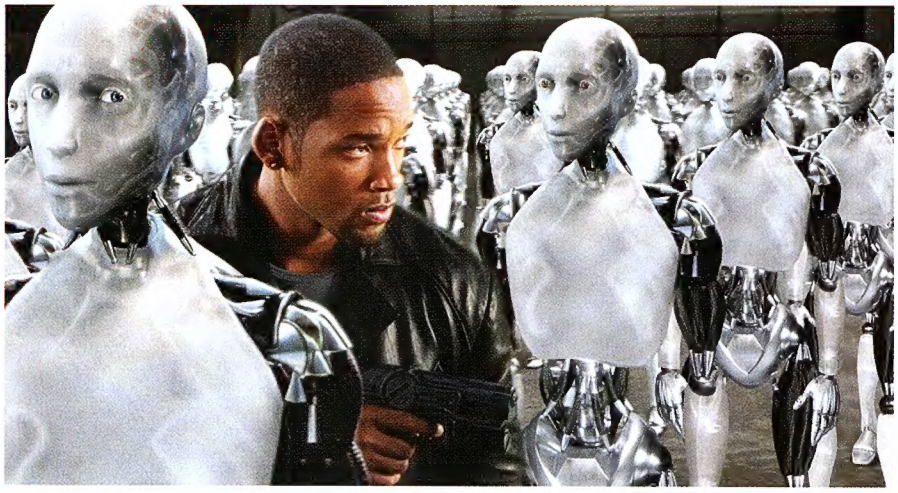
SHOULD YOU COVER YOURS TOO?

Facebook allows billions of people to share their personal data on the internet, but that doesn't mean its CEO isn't deadly serious about his own online privacy. First noticed by Twitter user Chris Olson, a photo posted to Mark Zuckerberg's profile has revealed that Zuck tapes over his laptop's camera and microphone jack. When you're as high profile as Zuckerberg is, we'd say that's a smart move.
SL

Bose hoping to inspire kids with its DIY speaker kits

TEACHING KIDS HOW SPEAKERS WORK.

Kids are more tech savvy than ever these days, which is why the audio engineers at Bose have designed a system to get youngsters interested in building speakers and understanding how they work. The BoseBuild Speaker Cube allows children to assemble a Bluetooth speaker from a set of individual parts using step-by-step instructions from an iOS companion app. Sounds good to us!
SL



Google making its own version of Asimov's 'Three Laws' for safe AI

Will Smith unavailable for comment.

Worried about robots with artificial intelligence? Never fear, for Google, inspired by science fiction author Isaac Asimov's Three Laws of Robotics, has published a research paper titled *Concrete Problems in AI Safety*, which discusses the potential challenges involved in moving forward with AI technology.

In the paper, the tech giant outlines some major hurdles it believes will need to be addressed in order to "apply AI in more general circumstances". 'Avoiding Negative Side Effects' aims to ensure that "an AI system will not disturb its environment in negative ways while pursuing its goals", while 'Avoiding Reward Hacking' aims to prevent robots from "covering over messes with materials it can't see through". Google also wants robots to recognise the difference between its training environment and other areas, stating that "heuristics learned for a factory workfloor may not be safe enough for an office". Measures should also be put in place for 'Safe Exploration', allowing robots to explore different strategies for their abilities without negative repercussions.
Stephen Lambrechts

Microsoft sued over Windows 10 forced upgrade

COMPANY MUST PAY A CALIFORNIA WOMAN $10,000.

If you aren't already running Windows 10, chances are you've been met with annoying upgrade reminders on a near daily basis, with Microsoft aggressively pursuing new users with its free upgrade offer. Not only has the company made it difficult for many people to opt out of installing its latest OS, some PC owners have found that Windows 10 has automatically installed itself without their explicit permission. That's exactly what happened to Teri Goldstein, a realtor whose work computer was rendered practically useless from the unauthorised Windows 10 install. That aggressive tactic has come back to bite Microsoft, though, with Goldstein taking the company to court and settling to the tune of US$10,000 (AU$13,554), requesting compensation for lost wages caused by her computer troubles and for a replacement PC. Though this amount is just a drop in the ocean for the US$69.3 billion corporation, it could open the floodgates for more unwilling Windows 10 inductees filing suits against Microsoft. **Stephen Lambrechts**

NSA looking to hack Internet of Things to spy on you

YOU CAN NO LONGER TRUST YOUR REFRIGERATOR.

At a recent conference on military technology, NSA deputy director Richard Ledgett told attendees that the agency is looking for ways to exploit Internet of Things devices. This follows similar comments by US Intelligence chief James Clapper, who told the Senate that IoT could be used "for identification, surveillance, monitoring, location tracking, and targeting for recruitment, or to gain access to networks or user credentials". SL

ISIS is winning the social media war

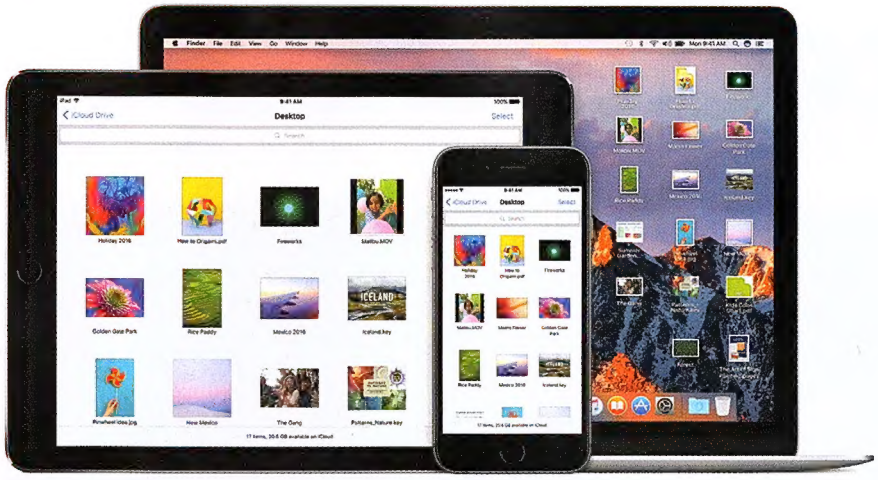
BY ACTIVATING RECRUITS THROUGH SOCIAL NETWORKS AND TEACHING THEM TO COVER THEIR TRACKS.

According to a new report by the Institute for Critical Infrastructure, ISIS is using its powerful social media presence to activate its mentally-ill 'lone-wolf' recruits. It does so by publishing lists of targets online and pointing unstable foreign jihadists like Orlando mass-shooter Omar Mateen towards them. The report also states that ISIS "teaches its members how to obfuscate their communications". SL

Greens calls for multi-party inquiry to create best NBN outcome

THE NBN NEEDS FUTURE-PROOFING.

Political leanings aside, it's hard to argue that the implementation of Australia's National Broadband Network has been anything but a total trainwreck. That's why the Greens is proposing a multi-party inquiry that would try to set a future-proof architecture for the NBN. Senator Scott Ludlam suggests the inquiry be "informed by an independent panel of technologists, academics, engineers, user advocates, advisers and other experts". SL



Apple WWDC highlights

The most-interesting Mac and iOS updates straight from Apple's annual dev conference.

Apple has announced a slew of new experiences at its Worldwide Developers Conference (WWDC) keynote in San Francisco this year, with some fairly significant changes coming to its OS X, iOS, watchOS and tvOS platforms.

For starters, the name OS X is no more — now named macOS, the Cupertino company revealed that its El Capitan successor will be called Sierra, and that it will bring with it more continuity across devices, such as the ability to copy and paste items between your Mac and iPhone. The files in your Desktop and Documents folders will also be accessible from all of your devices, and you'll also be able to use Apple Pay in Safari. Apple's personal assistant Siri is making her desktop debut, and you'll be able to instantly unlock your computer while wearing your Apple Watch. Sierra will be available for free sometime this spring.

iOS 10 was announced at the keynote, featuring several redesigned apps. Messages will let you customise speech bubbles, as well as send handwritten messages, stickers, animations and more. You'll also be able tap on specific words in your message to instantly transform them into emoji.

Photos is taking a page out of Google's playbook by letting you search your images by the people and objects within them, and a new Memories feature lets you relive your past by creating movies and collages from old pics. The Maps app will soon let you make reservations and will even point out coffee shops, restaurants and fuel stops.

Apps like Music and News are getting all new looks, and you'll be able to interact directly with notifications. You'll also be able to control your Apple TV with a new Apple TV remote app for iPhone.

The refreshed watchOS will come with new customisable watch faces (Minnie Mouse!) and a new app called Breathe which encourages you to take a moment for yourself. New workout metrics are on the way, and you'll soon be able to share fitness accomplishments with friends.

Stephen Lambrechts

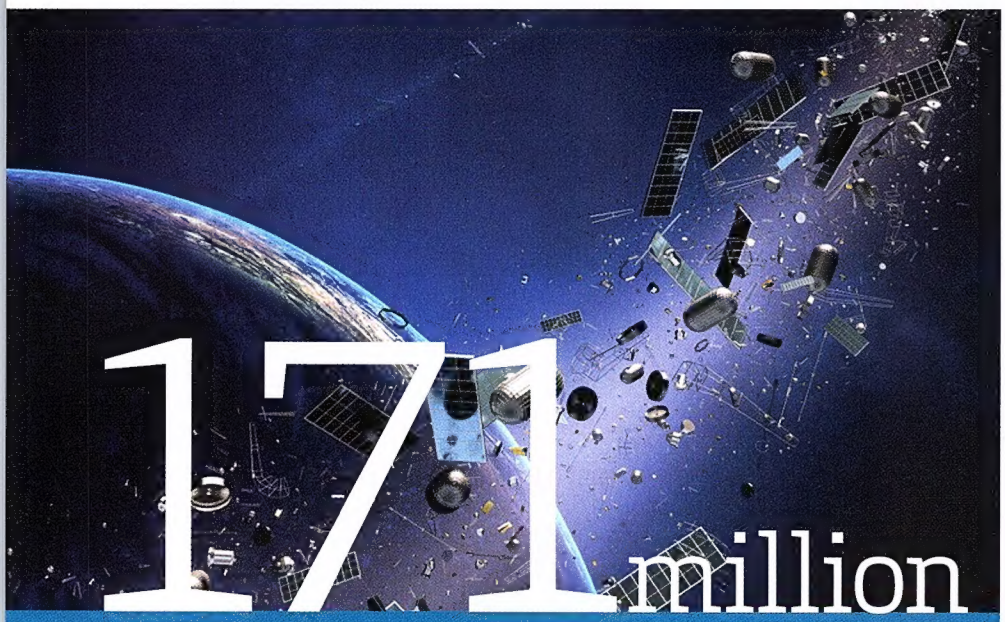
Microsoft ditches Xbox exclusives, gives PC some love

NEW CROSS-PLATFORM GAMING INITIATIVE ANNOUNCED.

Of the many announcements made at Microsoft's E3 conference this year, one in particular is likely to cause mixed emotions among Xbox One gamers. With the introduction of its new Play Anywhere cross-platform gaming initiative, which will see Microsoft Game Studios titles arrive on Xbox One and Windows 10 simultaneously, Microsoft has effectively brought upon the death of the Xbox exclusive. Franchises that have traditionally been released exclusively on Xbox consoles in the past, such as *Forza Horizon* and *Gears of War*, will see their next instalments available on PC. Even the (as yet unannounced) sixth entry in the system-selling *Halo* series is expected to arrive on Windows 10. It's not all bad for console gamers, though — digital purchases of Microsoft's games will be playable across both Xbox One and Windows 10, meaning you won't have to buy the same game twice. Not only that, gamers will be able to challenge each other across platforms, and save games will also carry over, too. **Stephen Lambrechts**

technotes

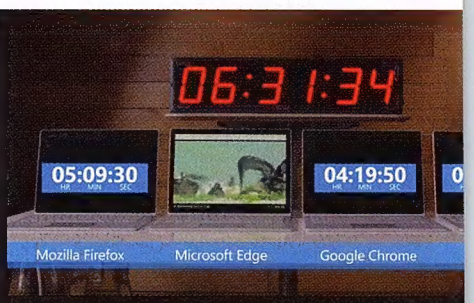
» CARMEL SEALEY LOOKS AT THE NUMBERS DRIVING THE NEWS.



171 million

PIECES OF SPACE DEBRIS IN ORBIT FROM 58 YEARS OF SPACE TRAVEL.

Ever since 1957, humans have been leaving bits behind whenever we've visited space. Now, the density of space debris surrounding the Earth has reached dangerous levels. Space debris is classified as any waste left over from rocket launches, disused satellites and broken-off tech; however, we only track objects larger than 5cm — which is only 20,000 of the 171 million pieces. Although a piece of debris, on average, drops out of orbit each day, scientists are still trying to figure out a way to deal with it all.



70%

THE INCREASED PERCENTAGE OF BATTERY LIFE MICROSOFT'S EDGE WILL APPARENTLY GIVE YOUR LAPTOP.

According to Microsoft, if you switch to Edge as your primary browser, you can dramatically extend your laptop's battery life — in some cases, up to 70%. In a videoed test, Microsoft set up four Surface Books and had each run HD video through a different browser until the battery died. Chrome stumbled first (at 4:19), followed by Firefox (5:09), then Opera (in battery saving mode, 6:18), with Edge coming out on top (7:22).

13%

THE FALL IN YEAR-ON-YEAR GLOBAL PC SALES IN Q1 2016.

According to the analysis firm Canalys, a mere 101 million PCs were sold in the first quarter of 2016, a 13% reduction in sales from Q1 2015 — the lowest number since the second quarter of 2011. But it wasn't just PC numbers that saw a drop. Sales of tablets also fell, with Apple selling just over 14 million devices — a 17% fall.

100 mph

THE PROPOSED MAX SPEED FOR COMMERCIAL DRONES IN THE US.

The US Federal Aviation Administration and Department of Transportation have proposed new laws to govern commercial drone activities. The new rules will include outdoor flying only, with a 400ft height restriction — unless it is filming a structure, then the restriction will be 400ft above the structure. The maximum speed will be limited to 100mph and a drone is not permitted to fly above anyone unaware of its presence.

3.6 million

THE AMOUNT OF ETHER STOLEN BY HACKERS IN DIGITAL HEIST.

The Decentralized Autonomous Organization (DAO), a crowdfunded investment fund, was attacked mid-June by a group of hackers. Exploiting a software bug, the thieves managed to make off with more than 3.6 million ether, an amount of Ethereum cryptocurrency worth between US$45–US$75 million. According to a developer, the hackers appeared to halt their attack by choice, not by any technical barrier, a worrying sign for the fledgling currency. ■

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MSY Technology	03 9560 2288	msy.com.au
PC Case Gear	03 9551 0889	pccasegear.com
Centre Com Sunshine PTY	03 8311 7600	centrecom.com.au
Scorpion Tech. Computers	03 8561 3200	scorptec.com.au
PLE Computers Melbourne	03 8375 5771	ple.com.au

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PC Solutions 4 U	08 89412119	pcsolutions4u.com.au

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Austin Computer	08 9201 2788	austin.net.au
MSY	08 9344 1002	msy.com.au
Netway Computers	08 9332 0888	netwaycomputers.com
Netplus Micro Computers	08 9242 7288	netplus.com.au
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PLE Computers	08 9309 4771	ple.com.au
Worldwide Net Solutions	08 9375 9666	netsolution.com.au
ARROW COMPUTERS	08 9258 7733	arrowcomputers.com.au

SA

Hypernet Computer Distribution	08 8340 2021	hypernetdist.com.au
MATS Systems	08 8186 2110	mats-systems.com.au
MSY Technology (SA) Pty Ltd	08 8212 1656	msy.com.au
IT&Computers	08 8186 2736	itwarehouse.com.au
Photech Computers Pty Ltd	08 8349 4334	photech.com.au

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Tech talking points

A rapid rundown of the most talked-about tech stories of the last month from the APC team.

MICROSOFT BUYS LINKEDIN FOR US$26BN

LinkedIn is a site that leaves many of us wondering 'What good is it?' but clearly Microsoft sees some sense in the business-oriented social network, as it announced it's acquiring the company for over US$26 billion. Microsoft's exact plans for LinkedIn are still unclear, but it's rumoured that numerous other tech giants were interested in acquiring the service, and that a bidding war with Salesforce is what ultimately drove the purchase price so high.

OCULUS DROPS DRM ON VR GAMES AND APPS

Facebook-owned VR company Oculus has had a tough 2016, having suffered months-long shipping delays on the retail launch of its Rift headset and then controversy after instituting DRM that prevented owners of a rival headset, HTC's Vive, from playing games and apps purchased on the Oculus Store. The company has since backtracked on the issue, removing the headset checks that blocked access – although Vive owners still need to use a third-party tool to access Oculus Store titles.

NETFLIX

Netflix offline-mode may be coming this year

Although the video-streaming service has been non-commital on the feature in the past, but has seemingly warmed to it in recent months. According to Dan Taitz, the CEO of Penthera — a company which specialises in caching video files for offline viewing — industry insiders have hinted that Netflix is currently working on a 'download-to-go' feature that will let users save files to their mobile devices for viewing without an internet connection. Taitz said he expects the feature to launch this year.

Xbox One to get a 'mid-cycle' upgrade

Microsoft used this year's E3 gaming conference to announce that it'll be joining Sony in releasing an 'enhanced' version of its current gaming console, which is currently dubbed 'Project Scorpio'. Like Sony's upcoming PlayStation Neo (AKA the 'PS4.5'), Scorpio will target 4K resolutions and VR, although Microsoft isn't building its own headset for the latter, instead claiming it'll be compatible with the PC's Oculus Rift. The new console is expected to arrive sometime in the second half of 2017.

Driverless cars claim their first fatality

With Tesla's electric vehicles now featuring the option to engage a semi-automated driving mode, it was a tragic inevitability that one would eventually be involved in a fatal crash. 40-year-old Florida man Joshua Brown was killed when his Tesla Model S, which had the hands-free Autopilot mode engaged, collided with a tractor-trailer on June 29th. Tesla claims that poor visibility prevented the Model 3's systems from seeing the heavy vehicle. This accident is the first in 130 million miles of Autopilot-activated travel in Tesla vehicles. However, on average, a fatality occurs every 60 million miles worldwide for regular hands-on cars.

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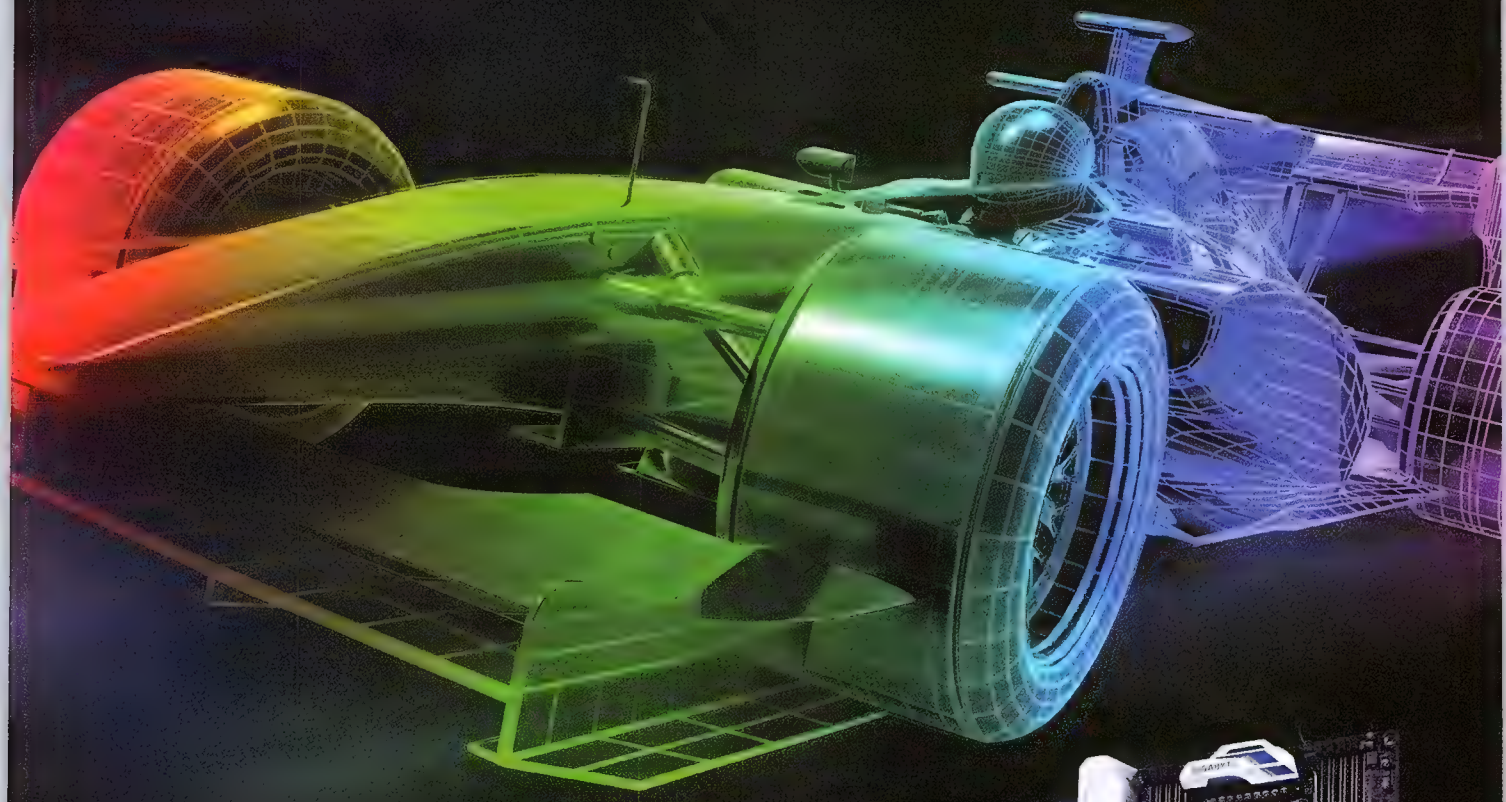

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*Features may vary by models. *The above photos are for reference only.

technotes

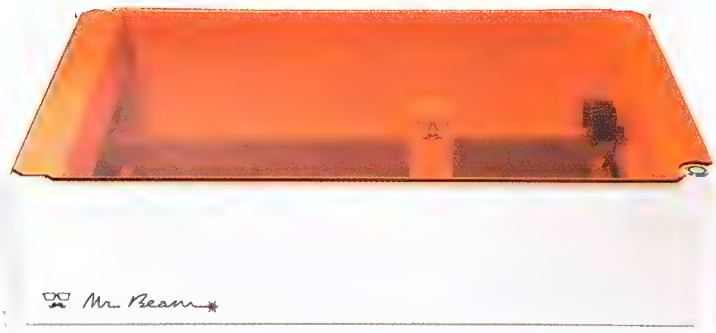
» GEAR WE WANT

MR BEAM II

A LASER CUTTER AND ENGRAVER.

MR-BEAM.ORG | ~$2,410

How many times do you curse yourself for not having a laser cutter to hand? Okay, not many, but you'll never know when you'll just really need one! This Kickstarter-funded crafting tool aims to bring laser cutting and engraving into the home. Open the web app, upload your design and Mr Beam will get on with the fiddly, crafty side of things. The machine can handle a variety of different materials, from paper to aluminium. The frame is actually pretty bulky, but it's been neatly designed, so won't be an eyesore at home.



HYPERKIN SMART BOY

OLD GAMES, NEW TECH.

US$59.99 | HYPERKINLAB.COM

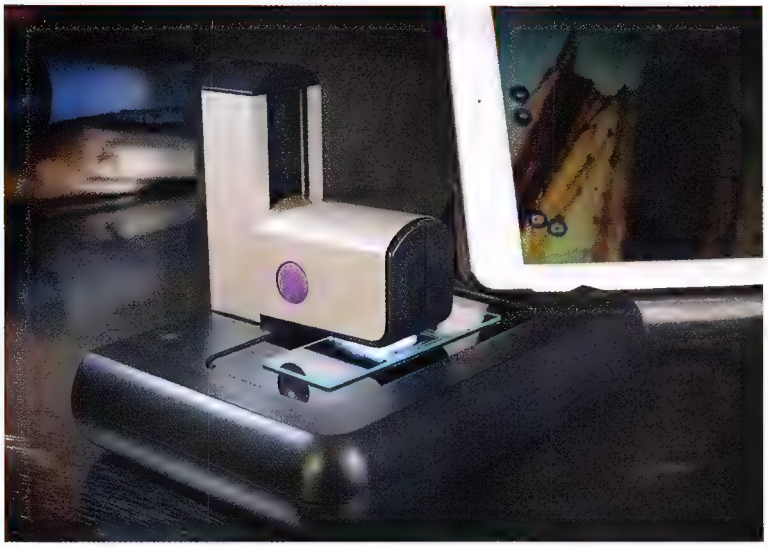
Although it was conceived as an April Fools' Day joke last year, the Smart Boy received so much attention that Hyperkin has decided to turn it into a fully functioning consumer product. The Smart Boy appeared on the E3 showroom floor this year, with the company suggesting that it would become available in December. Unfortunately, the retro gaming unit will only be available for use with Android devices, but just slip in your smartphone alongside an old Nintendo Gameboy cartridge and it'll use just the top half of the phone's screen to play games. If you can't wait until the end of the year, Hyperkin has developer kits that you can get your hands on now. **JB**

SONY MP-CL1 MOBILE PROJECTOR

MOBILE, MOBILE ON THE WALL.

$699 | WWW.SONY.COM.AU

It's a pretty common notion to wish that you could project a screen onto anything, like the back of the chair in front of you on public transport or the kitchen wall while reading a recipe on your smartphone. But most projectors are immobile and the ones that are portable aren't exactly things you're going to carry around for the odd occasion you'll want to display your phone as a big screen. Sony's Mobile Projector, however, is no bigger than most of the plus-size smartphones currently on the market, and you can display an HD screen at a size of up to 120-inches – well, provided you're in a pitch-black room. **JB**



IOLIGHT

A HIGH-QUALITY MICROSCOPE FOR YOUR IPHONE OR IPAD.

~$1,510 | WWW.IOLIGHT.CO.UK

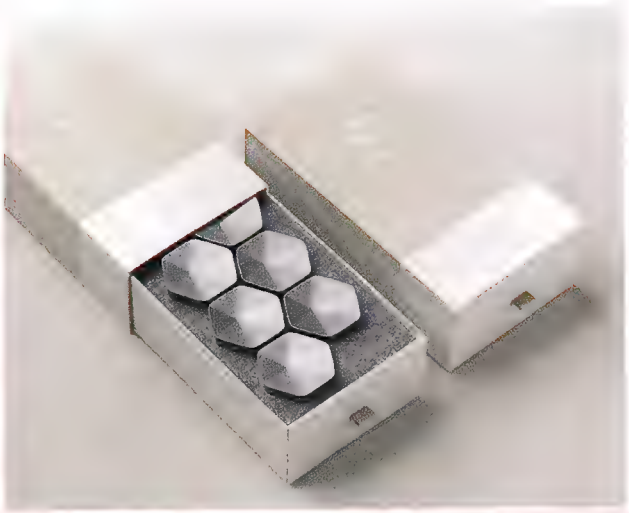
The ioLight is a device that claims to solve a problem you hadn't even thought of. High-end laboratory microscopes cost upwards of $5,400 and are fiddly to use, while cheap options simply aren't good enough for the pros. ioLight claims to be the mid-range solution that promises the best of both worlds. Okay, it's not for everyone, but it's great for people who need a portable microscope for fieldwork or teaching. It displays the resultant images on your iPad, so you can view them in even greater detail and back them up to iCloud for safekeeping.

LYCAN POWERBOX

SOLAR-POWERED BATTERY UNIT.

RENOGY.COM | ~$3,660

Gas generators tend to be noisy, bulky and harmful to the environment, but Renogy has turned to the power of the sun with the Powerbox. Thanks to what's touted as the most reliable and cleanest battery on the market, this little unit can transform solar power into good ol' AC, to power up smartphones, laptops, refrigerators and more. The Powerbox can be fully charged in just three hours using two solar panels and, because it's 100% battery powered, it's safe to use inside and out – it's also waterproof and wheeled, so is easy to move around. If the sun's not out, you can charge it from a socket, or even from a car charger.



PLUME

BIRDS OF A FEATHER.

US$49 PER POD (MINIMUM SIX) | WWW.PLUMEWIFI.COM

Generally, router manufacturers aim to fix the problem of Wi-Fi range in two ways: making a bigger router with more antennae that can throw a signal further or selling you an expensive Wi-Fi extender. The cost that goes into both of those can quickly add up. Plume is looking to solve the Wi-Fi problem via a different route – offering you many smaller and cheaper signal forwarders that can't throw as far, but can be placed in greater numbers around the house. Buy a Plume kit and you can order the exact number of Wi-Fi forwarders you need (it's recommend to have one for each room) in your house that'll all push the same signal, creating a shroud of Wi-Fi around your home. If you want a quick fix for a deadspot-free home, keep an eye open for AU availability. JB

The best tech of Computex 2016

It's the world's premiere PC show and it helps shape the next year of computing. Joel Burgess and Shaun Prescott report in on the big hits of this year's event.

It'll come as no surprise to most *APC* readers that virtual reality was front and centre at this year's annual Computex, which was held in Taipei in early June. In fact, the emerging tech has had such an impact that PC peripherals-company Cooler Master decided to use its premium floorspace for a VR skydiving demo, complete with a retractable floor, a suspended harness, and some atmosphere inducing industrial fans – there was no sign at all of the company's latest products. And though, for CoolerMaster, the use of VR was intended to simply attract the crowds, for many of the world's leading components and premium PC manufacturers, VR is the perfect tool to demonstrate the technological leaps they've made in the past year (or hope to make in the near future).

PC-makers like HP and MSI are so keen on VR that they've both made completely portable 'backpack PC' rigs that are capable of powering demanding VR titles without the hassle of being tethered to a stationary computer.

In an equally as effective but slightly less committed way, Gigabyte has developed a set of lightweight backpack straps for its Aorus X7 DT gaming laptop, which effectively transforms the machine into a VR-backpack equivalent without sacrificing your ability to use the device as a traditional laptop. Naturally, Nvidia's GTX 1070 and 1080 cards played an integral part in the show, with vendors eager to show off their own consumer versions and the announcement of AMD's new VR-ready Radeon RX 480 GPU (see page 26) was one of the biggest of the event. But although 2016 is unequivocally the year of VR and the vendors at Computex were displaying it in force, some of the most groundbreaking and interesting tech to come out of the show had very little to do with virtual reality at all. Read on as we reveal our favourites.

ASUS ZENBO

THE AI RUGRAT OF TOMORROW.

The practical uses of owning a talking, moving robot are difficult to really quantify at this point, yet there was an overwhelming sense that ASUS's Zenbo robot stole the show at Computex 2016. Imagine an Amazon Echo-like voice-controlled computer that, in addition to talking to you, can be interacted with using its tablet-sized facial display and will even follow you around the house in case it's needed.

While smartphone secretaries like Cortana and Siri haven't really become as ubiquitous as their designers had hoped, the Echo has made some decent headway in the US, showing us that computers are getting to a point where the main reason people don't talk to them is a cultural barrier, rather than a technological or usefulness one.

If we take this prototype at face value, then it'll reportedly be good at keeping your schedule, filing reminders and assembling to-do lists and even prompting you when one of these tasks needs doing. On top of this, Zenbo will read out recipes so you can get step-by-step instructions while you cook, recite stories for children with inbuilt facial animations (depending on what it's reading aloud) and take on any basic web searches you might need to do. But what was potentially even more intoxicating about this unusual but endearing baby-voiced robot was the promises it made to tap into third-party smarthome hardware, fitness trackers or health wearables, creating a smarthome ecosystem that you can control with your voice. And while there were other products that are likely to be far more practical than Zenbo, there's certainly something exciting about this technology and its potential, even if it is, perhaps, a long way off being fully realised.

ASUS ROG G31

A MONSTROUS MINI THAT WON'T NEED UPDATING FOR YEARS.

Gaming laptop brands like ASUS's Republic of Gamers and Alienware have, of late, been shifting a bit of their focus back to desktops, presumably to meet an increasing demand for high-end rigs to power VR. The ROG G31 will definitely satisfy anyone looking for top-of-the-line specs, because it doesn't get much more powerful than this. It boasts an i7 processor with a GTX 1080, and can support up to 64GB of RAM. Rather absurdly, it also boasts four (yes, four!) M.2 PCIe SSDs, one-click overclocking and a cooling system which involves "secret airflow tunnels" (ooh...) and a "3D vapor chamber (aah...). There's no word on how much this thing is going to cost locally yet, but it will most definitely set you back a lot. If you're after the most powerful VR-capable PC but don't want to lift a finger (or screwdriver), and if you like things that look like space rockets, this will no doubt appeal if you have a lot of money.

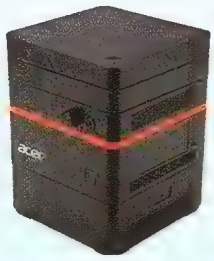
MSI VORTEX

A TIDY, AESTHETICALLY PLEASING GAMING RIG THAT'S VR READY.

Adding to the growing list of new desktop gaming PCs is MSI's new Vortex, which isn't quite as well-endowed as the G31 but will still suffice for current VR titles. It boasts an i7, GTX 980 with 8GB and 32GB of RAM – with a 128GB SSD and a 1TB HDD inside. While it's a small, 6.5-litre box that's a little Mac Pro-like, it doesn't feature any mobile components and carrying it to and from LANs – or just between rooms – shouldn't be a problem. This is selling for around $4,000 in Australia and, yes, you could most certainly build a more powerful PC for significantly less than that, but it's about as unique a design as we've seen and it's still VR-ready. If you like MSI's cyberpunk-ish design aesthetic (and who doesn't), you'll likely appreciate the vaguely cylindrical shape of this kit.

Mini boxes in a box

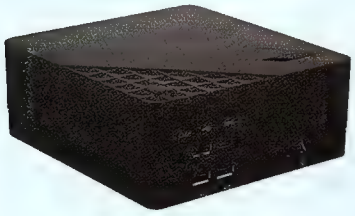
THE PALM-SIZED PC CONTINUES TO GET MORE POWERFUL AND APPEALING.



Acer Revo Build M2-601

A MODULAR MINI-PC FOR SCREWDRIVER PHOBICS.

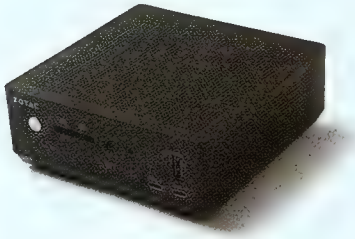
The concept behind the Revo Build is that separate modular PC components snap together, meaning you don't need to open a chassis or use a screwdriver. The small form factor and clean design is appealing, and it packs an i5, 8GB RAM and Windows 10 pre-installed. A great, Windows alternative to the Mac Mini, it's likely to cost around $400 locally.



MSI Cubi 2 Plus

A TINY PC BOX WHICH CAN VIRTUALLY DISAPPEAR.

This mini PC is roughly 15cm squared, and can be mounted to the back of a monitor, meaning it doesn't need to clutter your desktop. It can hold up to 32GB RAM, and carries a 6th Intel Skylake-S processor. It's not as stylish as the Revo Build above, but it's functional and, most importantly, inconspicuous.



Zotac ZBox Mi545 nano

NOTHING BUT THE RAWEST OF COMPONENTS.

This is about as stripped back as mini PCs come: it doesn't include an operating system pre-installed, and its dotted black shell is designed to take up as little space as possible. It boasts an i5 CPU and can carry up to 16GB RAM, with two front-facing USB 3.1 ports and some 3.0 ports on the back.

Gigabyte Aero 14

A ZESTY, COMPACT GAMING LAPTOP.

Gigabyte has been one of the top contenders in the ultraportable gaming laptop category for some time, with *APC* award winning models like the 14-inch P34W v5. So the company's newly announced ultra-slim gaming laptop, which comes in two uncustomarily zesty colour types, were some of the more unique gaming laptops on show. Though the new Aero 14 is 200g heavier than its predecessor at 1.89kg, we're guessing the new 3K screen and 50% extra battery capacity is to blame, and even so, it's ended up thinner than any other gaming laptop we've seen, impressively scraping in under the 2cm mark.

MSI GS63

4K GAMING ANYWHERE.

In much the same way as Gigabyte, MSI has updated its own competitive GS range of portable gaming laptops, with the easily-carryable 1.9kg GS63 Stealth Pro. It took out an official Computex 'Best Choice' Golden Award. MSI still hasn't catalogued final specs for the GS63, as its waiting for Nvidia to unveil its next generation of mobile GeForce GPUs, but the system is set to be available with a 3,840 x 2,160-pixel 4K display.

Gigabyte Aorus X7 DT

VR ON THE GO.

If you're more concerned about what your gaming laptop can do than about it being easy enough to move around, then the new Aorus X7 DT will be more your speed. Gigabyte somehow managed to pack a full desktop-grade Nvidia GeForce GTX 980 GPU in the compact 2.5cm-thick chassis to make a VR-ready laptop that'll weigh in at a manageable 3.2kg.

ASUS ZENBOOK 3 UX390

A SERIOUS CONTENDER TO TAKE ON APPLE'S AVANT-GUARD MACBOOK.

Apple may have come up with the smallest and slickest ultrabook with last-year's Core M powered 12-inch MacBook, but the ASUS ZenBook 3 UX390UA that was announced at Computex has a few key features that might let it blow the MacBook out of the water. Firstly, despite having a MacBook-like sub 13-inch form factor made of an anodised aluminium unibody, the laptop will come in CPU tiers extending all the way up to a Core i7 – a feat of engineering we didn't think was actually possible in such a slim chassis. It'll have a completely re-engineered 3mm-thick single-fan cooling system to cool those more powerful Core i chips. The ZenBook 3 will also host both a PCIe SSD and a SATA SSD – giving it a combined storage capacity of up to 1TB – and the higher-end configs will pack in 16GB of 2,133mHz RAM. At just over a centimetre thick and weighing in at only 910g, it'll actually be thinner than the 12-inch MacBook and still include a 3.5mm audiojack in addition to a single USB Type-C port. Honestly, the only downside we can see on the spec sheet is that it only has a 1080p screen... and could end up a bit expensive.

MSI VR GAMING BACKPACK

MAKING VR NINJA TURTLES.

VR is nifty, but in use one of the biggest reminders that you are in a virtual world is the cable tethering you to a computer. The bandwidth and minimal latency that VR demands means that wireless headsets are still some way off, but MSI has revealed another way to prevent the cabling from getting in the way of a free-roaming experience: its built a functioning consumer VR gaming backpack. You need a pretty powerful rig to get respectable VR up and running, so despite it only being a little larger than a console, it manages to squeeze in a Intel Core i7 K-series CPU and a full desktop Nvidia GTX 980 graphics chip. Powering a full 500-watt desktop PC setup with a battery pack is tricky for multiple reasons, but the prototype backpack that MSI showed off at Computex had enough charge to last for a minimum of 1.5 hours of VR and still weighed in at under 5kg.

ASUS ROG AVALON

REIMAGINING THE MODULAR PC.

When building your first PC, one of the most difficult things to wrap your head around is the limitations of particular motherboards and cases in being able to accommodate the varying physical sizes of components. The Republic of Gaming Avalon chassis was designed specifically to avoid all of these spatial restrictions by integrating a motherboard into the frame of the case in a way that prevents components from competing for space. Avalon looks more like a tabletop stereo system than a PC case, with a central compartment and upward-opening display door flanked by two outward-folding wings that allow easy access to the three compartmentalised segments. The top segment will be home to four RAM slots and your chosen CPU (with enough space for a directly-attached air cooling system), the first wing has enough room for big GPU systems, while the remaining wing holds the power supply unit and a water cooling block. Finally, four draws at the front of the unit allow SSDs to be mounted directly into the system, without the need for any cables.

DELL XPS 15

15-INCHES OF INFINITYEDGE DISPLAY.

We're rather fond of the Dell's XPS 13 laptop here at *APC*, so when we noticed that Microsoft was showing off a 15-inch version of the near borderless display, we were intrigued. The entry-level model comes in a little pricier than its smaller sibling, starting at $2,499, but interestingly, this 17mm-thick chassis is packing a dedicated Nvidia GeForce GTX 960M GPU. This makes sense considering the more expensive versions have to run a 4K display, but for the entry-level FHD screen, it'll give you a little extra power to run even the most recent games on lower graphical settings – a welcome perk from a more businesslike machine. In addition to a dedicated GPU, the refreshed XPS 15 conceals an Intel Core i7-6700HQ CPU, between 8GB and 32GB of RAM and a PCIe SSD that'll have a capacity between 256GB and 1TB. All this rounds up to a highly portable 1.78 kg, an impressive total weight for a powerful 15-incher.

ASUS ZenFone 3

THE UNEXPECTED ANDROID.

ASUS had a bunch to show at Computex, but one of the unexpected devices to come out of its bag of new goodies was the ZenFone 3. It's the smallest of a new range of three handsets, which start with this 5.5-inch screen size and extend all the way up to a giant 6.8-inch Ultra model. Each of these mid-range phones boasts a Full HD screen and one of either a Qualcomm Snapdragon 625 or 820 SoC.

Zotac Zbox PI221

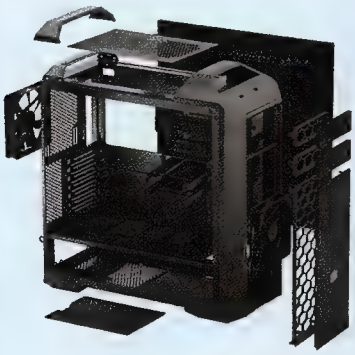
POCKET PC.

The 'compute stick' PC is an interesting, if somewhat niche, space that is potentially perfect for people who travel a lot, and though we've tested a few in the office, we've never seen one with a dedicated Ethernet port. Zotac's Zbox PI22 is more portable than your average smartphone, plugs into any display with an HDMI port and runs Windows 10, which, in our eyes, adds up to a winning combo.

Cooler Master MasterCase 5

FIT MORE IN.

Much like with ASUS's Avalon project above, Cooler Master has been angling towards modular PC cases that allow for uninterrupted upgradability with no compromise on the components that you can install. The MasterCase 5 series are big, but they not only include totally-modular exterior panels that can be swapped out at will, but also enough space for movable HDD bays and the room to accommodate up to three long GPUs. ■



There you have it, folks — the glory of the Rift, stripped bare.

Be warned — these super-delicate cables can be tricky to handle.

These snazzy UV LEDs let the IR sensor know which way you're facing.

Oculus Rift CV1

If only you could see what I've seen with your eyes.

BACKGROUND:

We've had our eyes on Oculus since the beginning, having dismantled both development versions of its VR headset. Today, we've got the real deal – the consumer-ready, OMG-it's-finally-here Oculus Rift. After four long years of development, what's changed? What's stayed the same? Can we put it down long enough to take it apart and find out? Grab your tools and join us at the teardown table, because we're deconstructing the Oculus Rift.

MAJOR TECH SPECS:

- Dual OLED displays with a combined resolution of 2,160 x 1,200
- 90fps refresh rate
- Accelerometer, gyroscope and magnetometer
- 360-degree headset tracking via Constellation IR camera
- Horizontal field of view greater than 100 degrees

KEY FINDINGS:

- This is the sleekest Rift yet – lightweight, impressively comfortable, and with earphones built in for maximum immersion. A thick foam frame attempts to minimise the effects of "Oculus Face". It's simply attached with clips. Fewer screws means less weight!
- Removing the adjustable earphones couldn't be easier. An embedded flathead barrel nut secures the speaker arm, and spring contacts connect it to the wires in the headband. We've seen our share of expensive, unrepairable, nigh-on-impossible-to-disassemble earphones, so this is welcome.
- Stretchy black Lycra surrounds the lenses, covering a thin plastic frame. This dustproof fabric protects the Oculus's innards, while allowing the adjustable lenses some freedom to move. But how to remove it? We're stumped – until our teardown engineer finds the hidden interior clips that secure the frame. After a few flicks of the spudger, it's free.
- Separating the lens assembly reveals the custom, non-Note, larger-than-lens-aperture display. These OLEDs measure 90mm apiece, for a resulting pixel density of around 456ppi. What was behind those lenses and dual displays? A super-sleek, spring-loaded, dual rack-and-pinion mechanism for adjusting the spacing between the display/lens assemblies. Next to come out is the LED driver board, featuring all the labels a reassemblist could want.
- Repairability Score: 7 out of 10 (10 is best). Cable management is much improved from the development kits, with a sturdy connector for easy removal. The earpiece speakers are easily removed, thanks to spring connectors. The face pad is held in with plastic clips, and pulls out easily. Getting inside is difficult, with hidden internal clips securing the dust shield. Replacing the head strap is impossible without cutting through the fabric on the headset. Intricate design and delicate ribbon cables make it very difficult to remove the lenses, displays, and motherboard. ■

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technotes

EPINIONS

PC MAGS ARE TOO TECHNICAL!

Having been a subscriber for many years, I am sorry to report that I am not happy with the way tech magazines these days are going. Readers are treated as if they are experts. Experts already know, so why would they want to buy a magazine and read how-to articles? They already know. The ones that do not know are left bewildered and give up. Consult some magazines from the past and note the difference.

On a different note, after having had all the bombardment from Windows 10 and a forced download, it'd be good to get an explanation in great detail of the difference between Windows and Linux with its offsprings. Many articles have been written about Linux, but I've never seen a convincing argument to change to it.
Walter Jakubzik

"Readers are treated as if they are experts. Experts already know, so why would they want to buy a magazine and read how-to articles? They already know."

Ed replies: *APC* has always offered a wide mix of stories aimed at users of many different types and of differing skillsets – our philosophy has always been that, even if you're a tech expert, we all have gaps in our knowledge and there are always new technology developments to learn about and keep on top of.

We do take a more entry-level approach to tech in our sister mag *TechLife*, so if you're finding *APC* too advanced, it might better suit your needs and interests.

On the Windows vs Linux question, we've done many introductory stories on the open-source OS over the 36 years *APC* has been in print, but it's definitely been some time since we've written a direct 'head-to-head' comparison between Windows and Linux. If other readers are interested in this, flick us an email to **apcmag@futurenet.com** and we'll consider putting together a story for a future issue!

WHAT'S REALLY 'NBN READY'?

I recently went shopping for a new ADSL modem as my old modem was faulty. In a few months' time, my connection will be upgraded to FTTN NBN, so I needed a device that had VOIP and a ADSL/VDSL modem that was NBN ready.

None of the major computer shops sold modems with VOIP or even VOIP adapters. As the only way of keeping your land line, once converted to NBN FTTN, is with either VOIP modem or an adapter, I find this surprising.

Only a very few of the ADSL/VSDL modems and some ADSL-only modems had an 'NBN-ready' sticker, and when you read the fine print, it was only the WAN port that was NBN compatible. There's no list of NBN-compatible modems on the NBN website and when I called they referred me to my ISP. My ISP would only recommend their own device.

I have read of at least one customer having his connection blocked because he used a third-party VDSL modem that was not compatible. There should be a list of compatible modems on the NBN webpage and only VDSL modems that are NBN-compatible should have an 'NBN-ready' sticker. Many customers will be badly inconvenienced and some will be out of pocket without such clear, honest labelling.
Carl Francis ■

APCMAG@FUTURENET.COM

Come on, have your say!

We want to hear what you think. Add to these discussions or email your views (in fewer than 250 words) to **apcmag@futurenet.com**. All correspondence becomes the property of *APC* and is subject to editing. Letters must include full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

BONUS PC GAMER DVD: BEST FREE GAMES
apc
August 2016
Issue 431
YOUR EXPERT GUIDE TO TODAY'S TECH
THE BEST PC PARTS RATED & REVIEWED
Intel X99 motherboards + top-shelf SSDs
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New GeForce GTX 1070s & 1080s rounded-up
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How to fix and enhance photos in Linux
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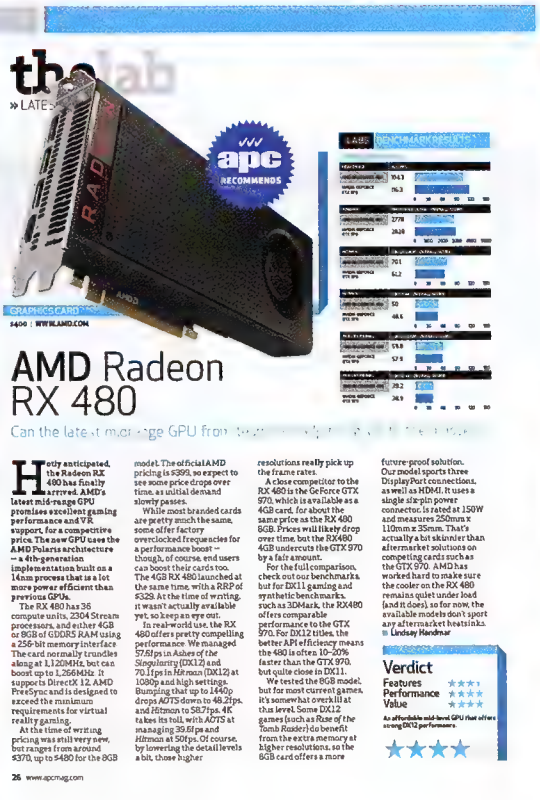
HOTTEST NEW TECH REVIEWED
Thinnest-ever laptop: HP's new Spectre tackles Apple head on
Intel NUC for gaming: The ultimate living room ready mini-PC?
Keyboard & mouse from the couch? New lapboards make it so!
AMD MAKES VR CHEAPER
New Radeon promises VR-ready performance for just $330: Does it actually deliver?



Inside APC

Find out all about *APC*'s editorial policies, test practices, how to read the benchmark results and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for over 35 years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer – it's in our name, after all – the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech too, from smartphones and apps to peripherals, accessories, online services and beyond. We have two main goals: to track down the best of modern tech and also to help our readers make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

INDEPENDENT REVIEWS

Championing technology doesn't mean we're unrelenting yes-men, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

LABS TESTING

Despite being a small magazine with limited resources, *APC* still still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule and where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.

Is your monitor anticompetitive?

Should having a specific piece of PC hardware count as an 'unfair advantage' in online gaming? Shaun Prescott weighs in.

Long before its official launch in June, many PC enthusiasts were mourning the lack of 21:9 aspect ratio monitor support for smash-hit *Overwatch*. Owners of extra-wide monitors are an evangelical bunch, so Blizzard's justification for a fixed 16:9 was eventually teased out. Writing on Reddit in July last year, a Blizzard representative said that the company wasn't going to include field-of-view (FOV) adjustments because it wanted to "avoid creating a situation of 'Haves and Have-nots,' where those who are aware of the [*Overwatch* FOV] slider are able to gain an advantage over those who aren't".

Fast forward a year, and Blizzard has suggested it will patch an FOV slider into the game, and representatives have stopped citing competitive edge as a cause for the early limitation. In May, a rep wrote on the *Overwatch* forums that "by keeping the aspect ratio fairly limited, we were able to allow the artists (primarily UI and animators of first person geometry, but also environment artists) to focus on creating the best experience for the vast majority of the player base. Beyond just framing preferences, currently there is also a lot of stuff that happens just off the edge of the screen which was not intended to be visible."

With that in mind, it's sensible to trust Blizzard regarding the unfair advantage – they know their game better than us. As esports grows, though, and as a title as successful as *Overwatch* begins to dig in its tentacles, questions of competitive advantages will continue to arise. *Overwatch* is not a resource intensive game – it's possible to run it (albeit poorly) on a PC with an integrated graphics card – but aside from meat and potatoes stuff like framerate and resolution, are there any other ways a rig can offer marginal advantages?

There are hardware cheats, of course, but these are easily identified by clients for all of the major esports-centric titles at present. Given the lack of universal regulatory guidelines for how a PC is specced out – and the impossibility of doing that, anyway – it's possible that there are no easy ways to gain an advantage that are known or concerning. Still, one of the biggest, and arguably most unfair, advantages a player can gain is early access to the game – and if long pre-release betas with exclusive or random access is considered an advantage for participating players, then *Overwatch* is among the worst offenders.

Blizzard operated a closed beta from October until late December in 2015, which opened again in February 2016 until May. Players granted access to the game during that period had months to hone their skills before anyone else, and while they don't have any material advantage, they've definitely had more time to get better.

Still, Blizzard's beta was an old-fashioned one, in that it was actually operated to test the game rather than market it. Additionally, the lack of competitive play at launch means everyone else has had the chance to catch up before it finally rolls out later this year. But with more and more games wanting to drive their stake into the competitive scene, questions of fairness are likely to arise more and more often. ■

ENDUSER

Share your stories!

If you have an iteresting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at **apcmag@futurenet.com**. All correspondence becomes the property of *APC* and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

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www.gigabyte.com

apc RECOMMENDS

GRAPHICS CARD

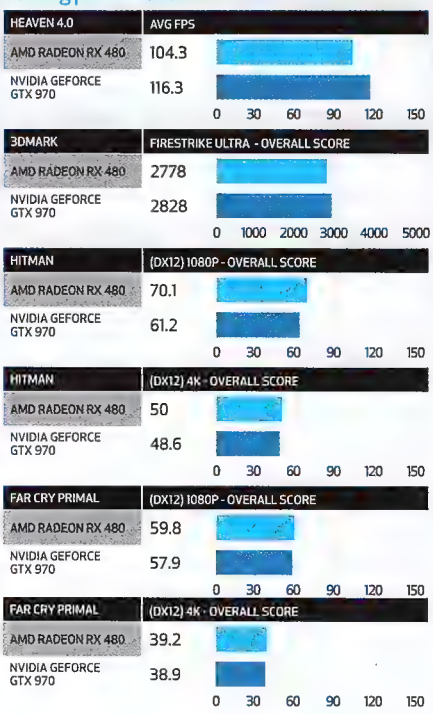
$400 | WWW.AMD.COM

AMD Radeon RX 480

Can the latest midrange GPU from team red help bring VR to the masses?

LABS BENCHMARK RESULTS

Gaming performance



Hotly anticipated, the Radeon RX 480 has finally arrived. AMD's latest mid-range GPU promises excellent gaming performance and VR support, for a competitive price. The new GPU uses the AMD Polaris architecture – a 4th-generation implementation built on a 14nm process that is a lot more power efficient than previous GPUs.

The RX 480 has 36 compute units, 2304 Stream processors, and either 4GB or 8GB of GDDR5 RAM using a 256-bit memory interface. The card normally trundles along at 1,120MHz, but can boost up to 1,266MHz. It supports DirectX 12, AMD FreeSync and is designed to exceed the minimum requirements for virtual reality gaming.

At the time of writing pricing was still very new, but ranges from around $370, up to $480 for the 8GB model. The official AMD pricing is $399, so expect to see some price drops over time, as initial demand slowly passes.

While most branded cards are pretty much the same, some offer factory overclocked frequencies for a performance boost – though, of course, end users can boost their cards too. The 4GB RX 480 launched at the same time, with a RRP of $329. At the time of writing, it wasn't actually available yet, so keep an eye out.

In real-world use, the RX 480 offers pretty compelling performance. We managed 57.6fps in *Ashes of the Singularity* (DX12) and 70.1fps in *Hitman* (DX12) at 1080p and high settings. Bumping that up to 1440p drops *AOTS* down to 48.2fps, and *Hitman* to 58.7fps. 4K takes its toll, with *AOTS* at managing 39.6fps and *Hitman* at 50fps. Of course, by lowering the detail levels a bit, those higher resolutions really pick up the frame rates.

A close competitor to the RX 480 is the GeForce GTX 970, which is available as a 4GB card, for about the same price as the RX 480 8GB. Prices will likely drop over time, but the RX480 4GB undercuts the GTX 970 by a fair amount.

For the full comparison, check out our benchmarks, but for DX11 gaming and synthetic benchmarks, such as 3DMark, the RX480 offers comparable performance to the GTX 970. For DX12 titles, the better API efficiency means the 480 is often 10–20% faster than the GTX 970, but quite close in DX11.

We tested the 8GB model, but for most current games, it's somewhat overkill at this level. Some DX12 games (such as *Rise of the Tomb Raider*) do benefit from the extra memory at higher resolutions, so the 8GB card offers a more future-proof solution. Our model sports three DisplayPort connections, as well as HDMI. It uses a single six-pin power connector, is rated at 150W and measures 250mm x 110mm x 35mm. That's actually a bit skinnier than aftermarket solutions on competing cards such as the GTX 970. AMD has worked hard to make sure the cooler on the RX 480 remains quiet under load (and it does), so for now, the available models don't sport any aftermarket heatsinks.

■ Lindsay Handmer

Verdict

Features ★★★½☆
Performance ★★★★☆
Value ★★★★☆

An affordable mid-level GPU that offers strong DX12 performance.

★★★★☆

apc RECOMMENDS

ULTRABOOK

$2,299 | WWW.HP.COM/AU

HP Spectre 13-v001tu

Are winners still thinner?

HP is looking to join the esteemed club of good MacBook Air alternatives with a new 13.3-inch ultrabook that it's simply called the Spectre. This is claimed to be the world's slimmest laptop at 10.4mm. For comparison, Apple's 12-inch MacBook and Razer Blade Stealth are both 13.1mm.

But HP is not selling the Spectre on that spec alone, and to its credit, it's chosen to focus on the essentials in its attempt to out-Apple Apple. This is not a 2-in-1, there's no touchscreen and no 4K display. This is still a premium laptop, though. The base Core i5 model we tested came with 8GB memory and a 256GB PCIe SSD, leaving it well-equipped to handle office basics and even a bit of moderate multimedia work. That 13.3-inch display is an IPS number with a 1080p resolution and a glass front that comes all the way to the rim of the lid.

The chassis is a mix – the top of the lid and keyboard deck are aluminium, while the base is woven carbon fibre. Despite having a 13.3-inch footprint, it's only 1.1kg, around 200g lighter than most competitors. HP has largely achieved that 10.4mm width by switching to prismatic batteries – which can be made ultra thin and shaped more conveniently.

Stylistically, it'll certainly turn some heads but we get the feeling you'll either love it or hate it – to us, the overall design and colour scheme kind of shouts "stylish business executive" and we'd suggest seeing this one in person before committing. We're hoping that HP introduces an alternative black and silver colour scheme that's a little more sedate.

The Spectre is genuinely great to use, too. Its glass trackpad is one of the best we've experienced on any Windows device, coming awfully close to matching Apple's MacBooks for responsiveness.

The chiclet keyboard is likewise well made and the aluminium deck supporting it means there's no flex at all when you're thumping keys.

The prismatic batteries offer up around four hours for common home or office productivity tasks, and nearly six when watching a 1080p film. HP has also added fast-charging tech into its battery, meaning it can reach 50% capacity in just 30 minutes. The caveat is that it requires a power brick about 10cm to a side.

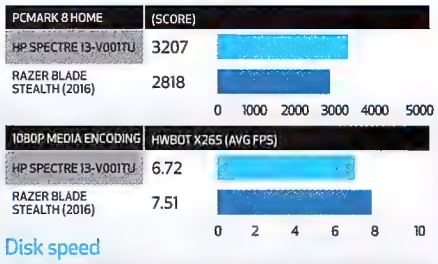
Unfortunately, the Spectre doesn't have any full-sized USB ports. You get two Thunderbolt 3 and one USB 3.1 (all of which use the same USB-C socket), with the latter doubling as the charge port. There's also a 3.5mm headset socket, but there's no SD or MicroSD card reader. There is, however, a USB-C to USB-A adapter in the box. Under load, the Spectre's small, fast-spinning fans put out a bit of noise, too.

With the entry-level model we tested, selling for $2,299, its starting price is significantly higher than most competitors. But if you're looking for a great no-nonsense Windows ultrabook and like the Spectre's overall design, it should definitely be on your shortlist.

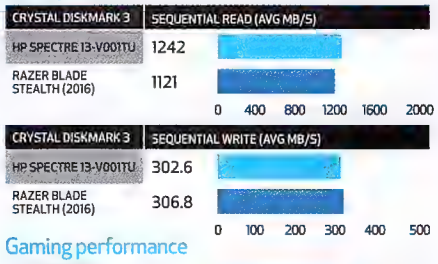
■ Dan Gardiner

LABS BENCHMARK RESULTS

General performance



Disk speed



Gaming performance

Battery life

Verdict

Features	★★★★★
Performance	★★★★
Value	★★★

Snazzy design and a low weight make this an appealing ultrabook, but the AU price is a bit of a hit.

★★★★

DESKTOP GAMING PC

$4,599 | WWW.ITDESTINATION.COM.AU

IT Cave 909

This lower-priced 'Powered by ASUS' water-cooled system packs in a lot of value and performance.

A monster of a gaming machine, the IT Cave 909 crams loads of high-end gaming hardware packed inside a gorgeous In Win 909 case. It also has a totally custom Bitspower water cooling setup, as well as adjustable colour change LED lighting. It's worth noting up front that the machine is aimed at gamers who want a specific sort of PC that does not sacrifice form over function. Of course, this raises the cost (but does not reduce performance) compared to a less extravagant build.

Like the other 'Powered by ASUS' Sensei-based PC's we've recently reviewed, this one has an Intel Core i7-6700K at its heart. The quad core CPU has been overclocked (and water cooled) up to 4.5GHz – a decent way above the stock max of 4.2GHz. Working in tandem is an ASUS STRIX GeForce GTX 980 Ti, which has had the stock air cooler replaced with a water block, whilst remaining covered by warranty. Both the CPU and GPU dump heat through a rear-mounted Bitspower Leviathan Xtreme 360 radiator, mounted in the rear of the case.

The IT Cave 909 also has 16GB of Corsair Dominator Platinum DDR4, as well as a 512GB Samsung 950 PRO NVMe M.2 SSD. There's no secondary drive installed by default, but there are four free drive bays available.

All the tasty hardware inside the PC is supported by an ASUS ROG Maximus VIII Hero Alpha motherboard. This choice ensures you have all the latest bells and whistles, such as 2x2 802.11ac MU-MIMO Wi-Fi with an external antenna, and USB-C. The board also includes SupremeFX audio with five 3.5mm audio jacks, and S/PDIF output. Power is supplied by a bottom mounted Corsair HX850i modular PSU.

It should come as no surprise that the IT Cave 909 offers excellent overall performance. It has more than enough grunt for all the latest games at 1080p, and can handle pretty decent 4K gaming, multiple monitors and VR. As the CPU has been overclocked, it also has more than enough computing power for productivity tasks, such as video editing or transcoding.

The cooling system does its job perfectly, but while it remains quiet most of the time, it's quite noticeable under a heavy load. Due to the layout of the case, connecting most peripherals involves removing one side panel, and even then, access is restricted due to wiring and water cooling. To help make things a little easier, two short USB extensions cables are pre-installed, so you can add devices down the track more easily.

Thanks to LED lighting strips, the PC does an admirable job of showing off its fancy internal hardware, as the light reflects and refracts through the solid acrylic tubing. The ASUS motherboard ensures that this system has loads of rear connectivity, including two USB 2.0, two USB 3.0 as well as both Type-A and Type-C USB 3.1 connections.

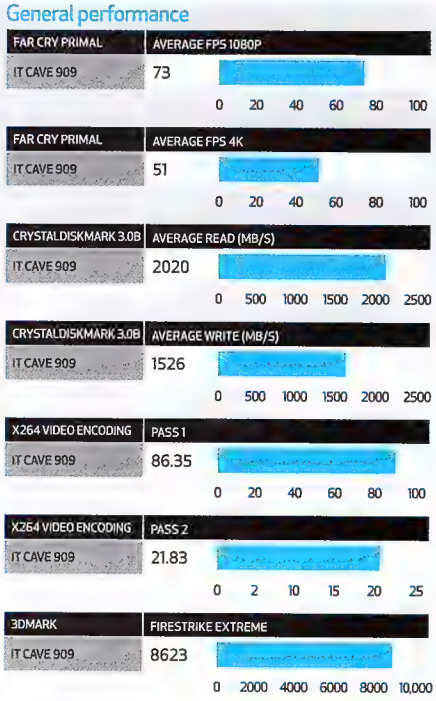
While the IT Cave 909 invokes a feeling of excess, it's in a good way, where you know that your PC is a pretty special custom-built gaming machine like no other.

Lindsay Handmer

LABS BENCHMARK RESULTS

Key specs: Intel Core i7-6700K @ 4.5GHz; ASUS ROG Maximus VIII Hero Alpha; ASUS STRIX GeForce GTX 980 Ti; 16GB Corsair Dominator DDR4; 256GB Samsung 950 Pro M.2; In Win 909

General performance



Verdict

Features	★★★★
Performance	★★★★
Value	★★★★

A big investment, but worth the cost for a powerful gaming machine with a standout design.

★★★★

MINI PC

$999 | WWW.INTEL.COM

Intel Skull Canyon NUC6i7KYK

Is there any sense in buying a higher-powered NUC?

It's probably fairer to call the Intel Skull Canyon machine a mini-PC rather than a NUC, as it does not use the same form factor as the smaller square PCs. Instead, the computer is rather thin, but extra-long in a video cassette-style shape. At first glance, the computer appears positioned as a mini gaming PC, perfect for living room use, and while that is somewhat true, the reality of Intel's Skull Canyon NUC is a little different.

The PC has a powerful Core i7-6770HQ CPU – a quad-core processor (with eight threads) that can boost from 2.6GHz up to 3.5GHz. It uses a 14nm process and has a 45W TDP – putting it well beyond the power of most NUCs. The CPU also includes Intel's Iris Pro Graphics 580, which can run at up to 950MHz and output 4K resolutions.

The system is sold as a barebones solution, and requires RAM and also an SSD added. It supports up to 32GB of 2133+ DDR4 across two channels, as well as dual slots for SATA3 or PCIe X4 SSDs.

As for this being a gaming machine, the Iris Pro graphics are only really suitable for playing new games at low detail settings, or older titles with everything on max. For example, *Bioshock Infinite* barely hits 20fps at 1080p with the settings on max, whereas the older *Grid 2* averages 83fps.

To get any real gaming performance, you need to run an external GPU. In this case, that's made possible with a 40Gbps Thunderbolt 3 port, which can handle an external GPU dock. The problem is that such docks are not readily available, let alone affordable.

On the plus side, the Core i7 CPU has loads of grunt for day-to-day productivity tasks, and the Iris Pro can power up to three 4K displays. Importantly, it's also got a pretty hefty cooling solution, so can run under full load without throttling, albeit with a bit of fan noise.

The NUC6i7KYK includes loads of connectivity options, with an SD card reader, dual USB 3.0, an IR port and a 3.5mm audio jack on the front panel. Around the back, it features Gigabit LAN, two more USB 3.0 ports, HDMI, mini DisplayPort, 7.1 channel audio out and a USB-C connector which can handle Thunderbolt 3, USB 3.1 Gen 2 or DisplayPort. Built in, the PC also has dual-band 802.11ac 2x2 Wi-Fi, and Bluetooth 4.2. The whole shebang measures in at 211mm x 116mm x 28mm – though it also has an almost as large 19V, 120W laptop-style power brick to add to the mix.

The Skull Canyon NUC is a bit of an odd beast, and it's hard to tell who Intel is trying to attract with it. While the underlying hardware is great, the barebones system starts at around $1,000, and still needs RAM and an SSD.

If you actually want to play modern games, it also needs a GPU dock and videocard, which makes it significantly more expensive than a gaming PC, and still not very convenient.

Lindsay Handmer

Verdict

Features	★★★½☆
Performance	★★★☆☆
Value	★★★☆☆

An interesting twist on the NUC concept, but the high price and average performance limit the appeal.

★★★☆☆

apc RECOMMENDS

DESKTOP GAMING PC

$6,499 | WWW.JW.COM.AU

JW Computers Power Max

A water-cooled 'Powered by ASUS' monster, complete with SLI graphics.

A bit of a mix between ASUS's Samurai and Sensei water-cooling PC designs, this JW-built system makes some strategic upgrades to create a unique but powerful gaming PC. For a start, it uses the ASUS ROG Maximus VIII Hero Alpha, rather than an ASUS Z170 Pro Gaming. Sitting inside under a water-cooling block is the Intel Core i5-6600K, a quad core that normally boosts from 3.5GHz to 3.9GHz, instead of the more powerful Intel Core i7-6700K. However, to ensure top performance the JW team has actually overclocked the i5-6600K all the way up to 4.5GHz.

To offset the gung-ho CPU, the Power Max runs dual ASUS STRIX GeForce GTX 980s set up in SLI. Importantly, both are water cooled, with a custom block that handles the two cards. The system also has 16GB of Corsair Vengeance DDR4 RAM, and a 512GB Samsung 950 Pro SSD. No secondary drives are included, but they are available as an extra upgrade.

The boffins behind the Power Max have put special effort into the Bitspower/EK acrylic tubing water-cooling system. Instead of squeezing the reservoir into the rear of the case, where it makes access to I/O ports awkward, the PC places it next to the GPUs. And for maximum bling, the PC uses pearlescent coolant, which looks great as it swirls gently under the case lights. The system dumps heat via a tri-fanned 360mm radiator in the rear. Importantly, it's very quiet, even when under heavy load. The cable routing is also worth a mention; it's easily the best laid-out and secured of the ASUS water-cooled PC's we've tested.

The internal illumination is also excellent, with Thermaltake colour-changing fans and recessed LED strip lighting.

The ASUS ROG Maximus VIII Hero Alpha offers more features than we have space to detail – including 2x2 802.11ac Wi-Fi, SupremeFX audio, as well both Type-A and Type-C USB 3.1 ports. The system's powered by a modular Cooler Master V1000 PSU, and sits inside an In Win 909 case. While huge, and with restricted access to the rear I/O ports, the tempered and tinted glass panels do a great job of showing off the internals.

The Power Max offers a fairly compelling mix of performance. While slightly slower than an i7, the overclocked i5-6600K is more than enough for CPU-intensive tasks, and won't bottleneck the GPUs. As a comparison, for single core tasks, it is almost on par with the i7, and only falls a little behind when using all four cores. By running dual 980s, the system excels at tasks that make good use of SLI, but doesn't offer a lot of value for less intensive games.

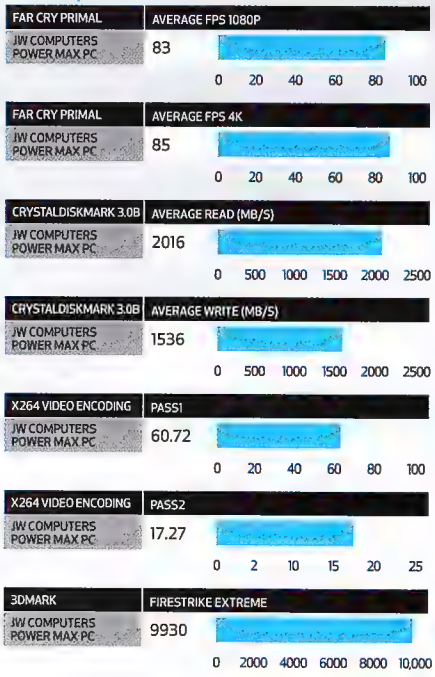
The Power Max is an interesting mix of SLI and a mid-range overclocked CPU, which all works very well together to create a high-end gaming machine that can handle 4K gaming. The downside is that the impressive hardware and cooling setup results in an expensive, albeit easy on the eyes, machine.

■ Lindsay Handmer

LABS BENCHMARK RESULTS

Key specs: Intel Core i5-6600K; ASUS ROG Maximus VIII Hero Alpha; 2 x ASUS STRIX GeForce GTX 980 (SLI); 16GB G-Skill DDR4; 256GB Samsung 950 Pro M.2 SSD; In Win 909 Case

General performance



Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★½

A rather niche machine, but for the right buyer, it's hard to say no to a powerful SLI setup.

★★★★½

apc HOT PRODUCT

GAMING LAPTOP

FROM $3,299 | WWW.GIGABYTE.COM.AU

Gigabyte P35X v5

A delicate balancing act between performance, features, noise and heat.

For years, the gaming notebook arena was dominated by large and bulky systems that performed well, but were arduous to carry. Razer's Blade line changed that, packing gaming hardware into a very sexy chassis. Now Gigabyte has upped the ante by including a GTX 980M instead of the less potent GTX 970M.

The result is almost a gaming laptop rather than a gaming notebook, though you probably don't want to game with it on your lap. All that performance in a 21mm-thick chassis that weighs 2.4kg means it can get toasty under load – we measured surface hot spots in excess of 60°C while gaming, though mostly at the back-middle (near the power button), where you're not as likely to come into direct contact. The added size also allowed it to pass torture testing, albeit at a very audible 47dB.

If that was the only thing going on, the P35X would be a good option, but Gigabyte includes plenty of other high-end features. The display is a 4K IPS panel, and while that's too much for the GPU at high/ultra settings, on a 15.6-inch display, there's no arguing it looks crisp. There's also a 256GB SM951 NVMe drive, a 1TB hard drive, and a 75.8Wh battery. Oh, and for all you holdouts who like physical media, they've even stuffed in a swappable storage bay; our unit had a Blu-ray combo drive, but it can be used for another 2.5-inch HDD/SSD.

When it comes to performance, the P35X v5 doesn't disappoint – from storage tests to CPU performance to gaming, it handles everything as well as you would expect. The GTX 980M is about 20% faster than a GTX 970M, and battery life remains a respectable four hours, beating the recent MSI GE62 and ASUS G752VT by well over 50% in our rundown testing. And how about that modern SSD? It's typically two to three times the performance of a SATA drive, reaching 2,254/1,249MB/s in sequential transfers.

Style-wise, the P35X is either a welcome break from the garish gaming notebooks, or it's rather drab-looking. Compared to the Razer Blade 14, it's nowhere near as sexy, and the casing is mostly plastic instead of machined aluminium. Keyboard backlighting is white LED only, and the keyboard itself is a little softer than we like. The touchpad is somewhat lacking, too, with integrated buttons that don't always respond. Also, that 4K display isn't G-Sync enabled, so while, in theory, you can play some games at 4K, in practice, you'll mostly end up running them at 1080p.

None of these are major issues, though, and as an entire package, the P35X v5 is well rounded. The price is competitive, too, and the feature set is excellent – it's amazing to see a thin chassis with all this performance that still elects to include a swappable drive bay. Some of these compromises are a forced choice, as well: you can't have G-Sync with Optimus, so you either get G-Sync or improved battery life.

We like the P35X v5, and for some, it's going to be a better gaming laptop than a bigger option from ASUS or MSI. Others will lust after the Razer Blade. If you're looking for something with a bit more performance without added weight, the P35X is impressive.

Jarred Walton

Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★★

Impressive performance in a compact size; nice 4K display; good battery life. Can get hot and noisy under load.

★★★★½

$7,500 | WWW.ASUS.COM/AU

ASUS RoG GX700

Is there such a thing as too much gaming cred?

The GX700 is a bloody ridiculous laptop. ASUS says it's a product that "raises portable gaming to new heights", and while that's true in a sense, it's also a stark reminder that the term 'portable' is relative.

The GX700 is so big and heavy that it ships in its own wheeled-and-well-padded suitcase, and while its specifications are sky-high, they're matched by an equally ridiculous $7,500 pricetag. This, clearly, is a product for gamers who also happen to be in the 1%.

It's a product in two parts. The first is a beefy 3.9kg 17.3-inch gaming laptop powered by a 6th-gen Intel Core i7 CPU and a desktop-class Nvidia GeForce GTX 980 graphics chip. The second is that big crab-like box around the back, which is actually a special dock that ASUS has dubbed the Hydro Overclocking Station or HOS. Drop the laptop onto the front of the dock and then push down on that big silvery lever on the back and the HOS sockets water-cooling hoses right into the back of the GX700, adding to the laptop's own internal coolers with a whopping liquid-cooled external one.

The 'overclocking' in the name isn't just there for a laugh either: you actually can overclock this beast when it's docked, which is done via ASUS's built-in RoG Gaming Center utility. The latter lets you tweak GPU speeds on the fly and it is relatively easy to use, with just a couple of presets for the CPU (5% and 10%) and two sliders for the GPU to adjust to increase speed. Voltage tuning and other esoteric settings are all taken care of automatically.

That said, we did manage to lock the system up by pushing it too hard when overclocking – we managed to get it stable at around 8–10% faster than stock, providing an equal increase in gaming framerates.

There are actually two versions of the GX700: we tested the 'entry-level' version, which includes a 512GB SSD (actually a pair of PCIe NVMe drives in RAID), plus 32GB of RAM and a 1080p G-Sync display. There's also a higher-end edition that doubles the SSDs to 1TB total and RAM to 64GB (our test unit actually had the latter) and bumps the display up to 4K and still has G-Sync.

Gaming is a dream – framerates on most of our test games were above 100fps and, with G-Sync visuals, were buttery smooth. The full-size keyboard feels great and is matched by a huge trackpad – although you're going to be using a mouse with this one most of the time, and one is included (an ASUS RoG Sica). The display doesn't have the best viewing angles, however, and we felt its contrast could have been a little wider: some detail was lost in very dark scenes in games and movies. On the plus side, fan noise is fairly minimal.

Battery life on the GX700 isn't great, although to its credit, our test unit did manage to eek out 2:08 hours in our tough PCMark 8 Home test. (Many competitors struggle to hit even 1:45 hours.)

As with most laptops, there's not much in the way of upgradability. While you can get to the M.2 storage and memory slots on the underside, doing so will void your warranty. You won't be able to swap the GPU out for a new one, although the system as a whole will support plugging in upcoming Thunderbolt-connected external GPUs.

This is a neat showcase of what laptop gaming tech can do. But would we buy one? Hmm... ■ **Dan Gardiner**

Verdict

Features	★★★★½
Performance	★★★★★
Value	★★

Lives up to basically every claim it makes, but the price is off-putting.

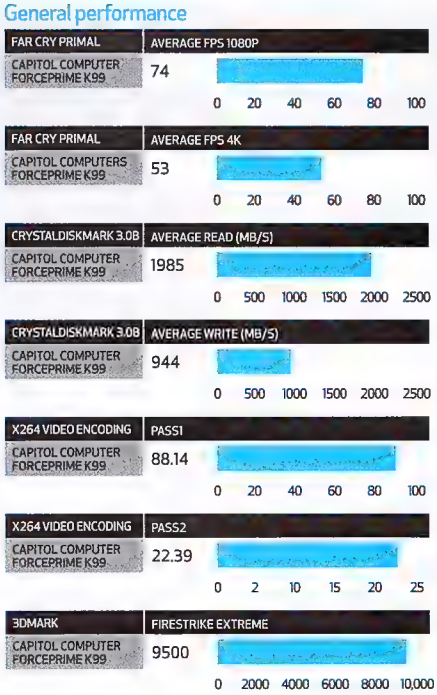
★★★★☆

$5,499 | WWW.CAPITOLCOMPUTER.COM.AU

LABS BENCHMARK RESULTS

Key specs: Intel Core i7-6700K; ASUS ROG Maximus VIII Hero Alpha; ASUS STRIX GeForce GTX 980 Ti; 16GB 3200MHz G.Skill DDR4; 256GB Samsung 950 Pro M.2 SSD; In Win 909 case

General performance



Capitol Computer ForcePrime K99

A beastly 'Powered by ASUS' desktop that'll let you get your game-on in 4K and beyond.

Capitol Computer's ForcePrime K99 is a custom overclocked and water-cooled gaming desktop that's roughly built to the ASUS Sensei design we looked at last month (see APC 430, page 25). To ensure enough room for all the tasty hardware, the computer is built inside an In Win 909. Not a case for the faint hearted, it's a huge slab of aluminium and tempered glass. While it looks great (and shows off the internals), the whole build is extremely heavy, and isn't a PC to haul along to a LAN unless you have a strong friend to help.

Inside is ASUS ROG Maximus VIII Hero Alpha motherboard, which has all the high-end features you crave. The K99 uses the ever popular Intel Core i7-6700K, albeit with a few tweaks. While the CPU runs at 4GHz normally, the Capitol Computer boffins have overclocked it up to 4.6GHz. To handle your every gaming need, the PC also has an ASUS STRIX GeForce GTX 980 Ti videocard and 16GB of G.Skill 3,200MHz DDR4. The machine opts for an ultra-fast M.2 256GB Samsung 950 Pro SSD, which can hit very impressive 1,985MB/s read and 943.5MB/s write speeds. There's also a 3TB 7,200rpm Seagate HDD. The whole kit and caboodle is powered by an In Win 900W 80+ Platinum modular PSU.

The K99 has a custom liquid cooling system, using Bitspower water blocks, custom acrylic tubing and stand out red coolant. The loop handles both the CPU and GPU, but thanks to separate front and rear 360mm and 240mm radiators, each component gets freshly chilled coolant. For normal use, the K99 is very quiet, but does ramp up in volume under heavy load.

As expected, the K99 is more than a match for the latest games at 1080p with the details cranked up to max. For less intensive titles, it's probably overkill, but has plenty of grunt to foray into multi-monitor and 4K gaming. A single GPU also has the advantage of avoiding any SLI support or compatibility issues, whilst still retaining the space to drop a second card in as a future upgrade.

While the roomy design of the In Win 909 case is great for building a water cooled system, it can be a bit fiddly to set up, as the motherboard rear ports need one side of the case removed before they can be easily accessed. While the K99 cable routing is great up front, it's a little sloppy in the back, with fan wires in the way when plugging in peripherals.

The ASUS ROG Maximus VIII Hero Alpha is a very well featured motherboard, with plenty of connectivity options for upgrades such as extra drives. It also has built-in 2x2 802.11ac MU-MIMO Wi-Fi (with external antenna), sports USB 3.1 in both Type-A and Type-C connections, and has SupremeFX audio.

While fairly pricy, the K99 has the performance and top notch water cooling to appeal to gamers who want to show off their machine.

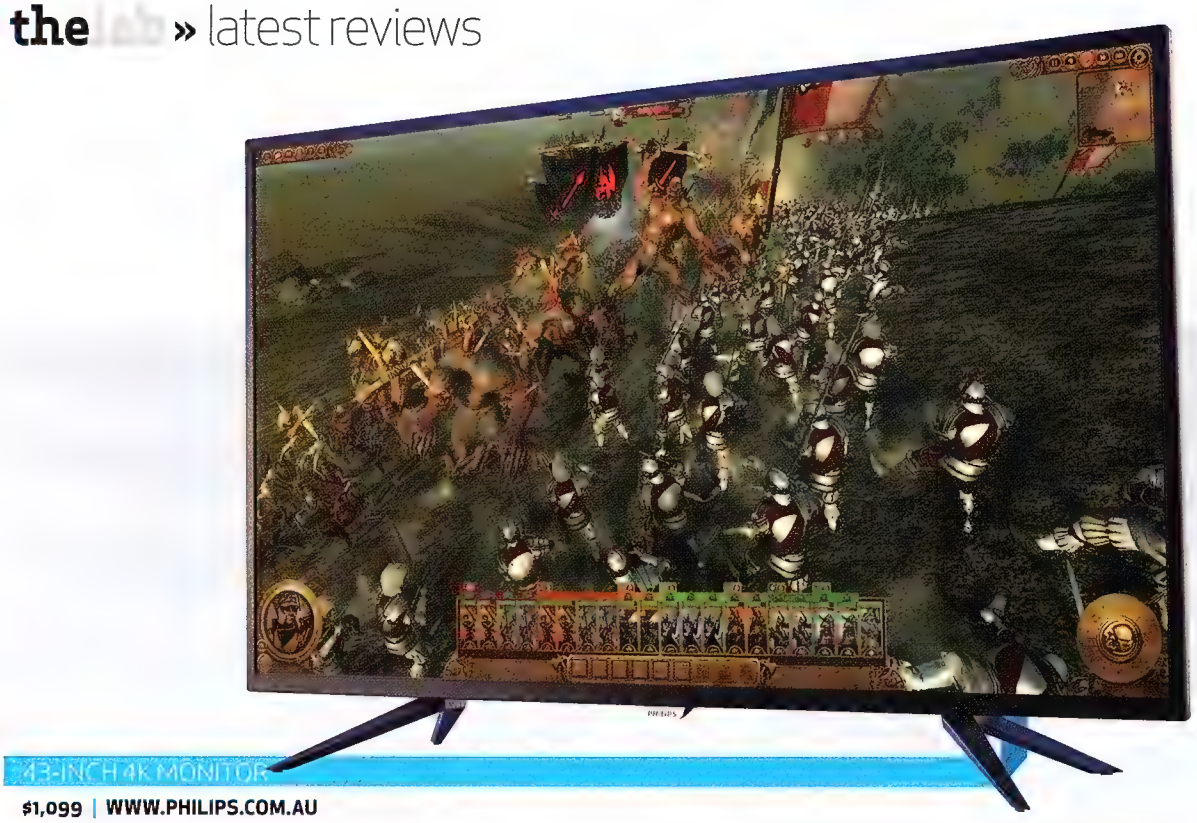
Lindsay Handmer

Verdict

Features ★★★★
Performance ★★★★
Value ★★★½

A high-end single GPU gaming machine that is powerful enough to explore 4K gaming.

★★★★½



43-INCH 4K MONITOR

$1,099 | WWW.PHILIPS.COM.AU

Philips BDM4350UC

Another 4K HDTV in PC-monitor drag? Not quite...

Buying a new HDTV? Then you'd be crazy not to pick up a 4K-capable screen. 4K HDTVs are now so cheap, they're giving 'em away in boxes of Wheet-Bix! Well, almost. But does a big 4K screen necessarily make sense for your PC?

4K TVs don't always make for good PC monitors. Early 4K TVs juddered along at 30Hz when connected to a PC. That's been solved with more recent screens, thanks to the addition of HDMI 2.0 and support for 60Hz refresh at 4K resolutions. But problems remain.

For starters, HDTV panels tend to be of the VA variety, in terms of panel. The net result is uber-saturated colours, which is great for an HDTV but less suitable for PCs, where accuracy is at a premium. Input lag and signal processing anomalies thrown up by the cheap electronics used in affordable 4K TVs only make matters worse.

With all that in mind, what to make of the new Philips BDM4350UC? First impressions are unsettling. At 43 inches and with fixed HDTV-style legs, rather than a stand with some kind of adjustability, the thing screams "HDTV". But then you spot that the panel tech is IPS (rather than VA) and has a full complement of video inputs, including DisplayPort, it looks a lot more promising.

Fire her up, and the basic quality of that huge IPS panel is obvious enough. Philips already offers a 40-inch HDTV-derived 4K monitor in the BDM4065UC. But that model uses a VA panel, and the difference is marked. The BDM4350UC's colours are much more natural. We're also pleased that the extra three inches haven't detracted tangibly from sharpness or clarity.

Sure, it's the same 3,840 x 2,160 pixel grid as its 40-inch sibling, but the 102ppi is still only marginally worse than a 27-inch monitor with a 2,560 x 1,440 native resolution. With a rated response time of 5ms, the BDM4350UC is reasonably rapid, too. From here, however, the screen turns a little sour.

The panel puts a serious premium on viewing angles when used as a PC monitor. You sit much closer than you would when using such a large panel as a TV. That means the edges of the display are at quite an oblique angle, but also at a dramatically different angle to the centre of the panel. The upshot is a noticeable drop off in brightness in the corners of the screen.

We noticed just a little input lag, too. It's not a major issue – nothing like as bad as seen on those notoriously laggy early PVA monitors from around a decade ago – but it will be enough to bother fans of hair-trigger online shooters. There's also some slightly odd image borkiness, which initially looks like plain old banding, but is more likely signal interference associated with the image processing electronics. This is something that the BDM4350UC's 40-inch sibling also suffers from.

All of this makes for a mixed result for the new Philips BDM4350UC. The glories of the 43-inch IPS panel are undeniable.

4K is a beautiful thing on such a huge, high-quality screen. With that, however, come issues that would be hard to swallow on a $300 panel, let alone something over $1,000. But if you understand the issues, and think you can live with them, then we are happy to give this panel a qualified thumbs up.

Jeremy Laird

Verdict

Features	★★★½
Performance	★★★★½
Value	★★★★½

Not quite a dream screen, but this big beauty still impresses on some fronts.

★★★★½

BROADBAND ROUTER

$745 | WWW.DRAYTEK.COM.AU

DrayTek Vigor2925Ln Dual-WAN Security Router

Data security and link resilience all in one.

For anyone whose business relies on having internet access, some kind of failover is absolutely essential. Now, a number of routers support the attachment of USB 3G/4G modems as an alternate WAN device, and you can also pick up Wi-Fi 3G/4G adapters for about $100 or simply use tethering on your mobile, but if you want real continuity of service, then a router with built in LTE support and failover is fantastic.

The DrayTek Vigor 2925Ln is such a router. It has an actual SIM card slot and internal 3G/LTE modem, as well as two large attachable antennae (with convenient magnetic bases) for LTE reception. Those antennae make a big difference. We tested a Vodafone LTE service with Speedtest.net using a tethered iPhone 6 and received a download speed rating of 27.3MB/s; we then put the SIM card in the router and hit 35.2MB/s, a notable difference. There are also handy extras, like the ability to send SMSs through a web interface, as well as receive router alert and notifications via SMS. You can also reboot the router using SMS, which is great for remote managed installations.

The Vigor 2925Ln is more than just a router with integrated LTE, however. It has a host of features that support security and management far beyond that found in typical consumer and "prosumer" routers. Those additional features come at a cost – both financial and in terms of complexity – but if you're a technical user who wants a lot from your router, the DrayTek has just about everything you need.

One highlight is the load balancing system, an option that does much more than simply balance internet usage between the two WAN ports and the LTE port or act as a failover in case of lost connectivity. It allows a complex series of routes to be created, routing certain connections through specified LAN, WAN or VPN ports. If you want a specific connection to be routed through a VPN, for example, while all other traffic goes through the regular WAN port, you can set it up here. There are also tools for managing the WAN budget and individual usage and much more.

Then, of course, there are the VPN functions, which have been improved substantially over earlier iterations of DrayTek firmware. You can set the router up as a VPN server or as a LAN-to-LAN gateway, with PPTP, L2TP, IPSec and SSL supported.

However, the wireless support is a weak link. As it stands, the router only supports two-antenna 802.11n, and for any serious network additional access points will need to be added.

Its Wi-Fi weakness aside, the 2925Ln is an impressive small business router, perfect for satellite offices and where connection security and resilience are paramount. It could find use in consumer environments as well, although the administration interface is not for the neophyte. It's complex and powerful, giving you a lot of options, but only if you know what you're doing.

Nathan Taylor

Verdict

Features	★★★★½
Performance	★★★★
Value	★★★½

A capable small-business router with some big-business security options and tools. Support for LTE is great.

★★★★☆

"With a printing resolution of 9,600 x 2,400, you'd expect firm, good-quality images, and doubly so, since the printer requires six individual ink tanks."

ALL-IN-ONE PRINTER

$249 | WWW.CANON.COM.AU

Canon MG7766 Gold

A multifunction inkjet that's not quite in first place.

Printers are the microwave of the tech world. You need one, sometimes, and then it's just there – a dispassionate block that neither enhances nor detracts from the room it lives in. Canon's latest home/small business unit attempts to add a touch of allure, by draping itself in gold paint.

Well, it's more of a bronze effect, and nowhere near as shiny as the press images would have you believe. Under the matte exterior lies a wireless printer, scanner, copier that will print from your Mac (Mac OS X 10.7.5 and above) and Windows (XP SP3 to Windows 10) laptop or desktop, as well as iOS and Android. Chromebooks aren't mentioned, but the MG7766 (as with all 7700 series printers) support Google's Cloud Print apps, as well.

Initial setup is straightforward – we got our test unit running through our router to an office MacBook Pro, and Sony Xperia Z5 (running Android 6.0) in minutes.

Printing on a local network is simple, and the MG7766 communicates via your router, NFC, direct Wi-Fi, USB and even over a LAN. Android and iOS users will have to download a dedicated app, which is fine for printing locally, though files need to be saved on local storage (say, photos). The app will prompt you to turn on your WiFi if it's off.

However, printing from cloud services takes bit more effort. Flickr, Facebook, Instagram, Google Drive and Dropbox have their logos splashed across the printer's packaging. We spent a few minutes on our Android phone going back and forth with the printer's 'cloud' registration process, and found that only one Google account can be matched to the printer at any one time. Not so bad for home users, though small business owners may have to look elsewhere if they want staff to send documents back to base without having to convert to PDF first. Connectivity aside, the MG7766 has two trays for holding paper, and the capability of printing directly to DVD/BD/CDs. The top tray holds 20 sheets of 4x6- or 5x7-inch photo paper, and the bottom 125 sheets of A4, as well as myriad sizes of lesser ratios. With a printing resolution of 9,600 x 2,400, you'd expect firm, good-quality images, and doubly so, since the printer requires six individual ink tanks (CMYK, grey and a larger black tank). However, a high-resolution (1,176 x 1,184) photo printed onto the supplied glossy 4x6-inch paper came out dark, with very obvious banding and lack of detail. Colours were vibrant, but the overall picture was disappointing. Canon quotes approximately 3,000 pages in black and white for A4, and 120–180 in colour before having to replace the ink. Although we used the app to print from our Android, SD card and Pro Duo slots can also be employed for images.

Stick to text documents on bog-standard A4 and the results are acceptable. Canon quote 15ipm for black and white, and 10ipm for colour A4 – hardly lightning-fast, but the printer is pretty quiet as it churns out the sheets, and a specific 'quiet mode' turns it down further at a slight cost to print time.

You're buying this for the aesthetic, though. While the gold shell, er, isn't so much, it's still a fine-looking unit. The 9cm/3.54-inch touchscreen breaks up the expanse of bronze-y gold, and the panels on the front are capacitive, too, and only light up when required.

Paul Taylor

Verdict

Features	★★★★
Performance	★★★½
Value	★★★

A touch expensive but a fine performer that's ideal for business documents.

★★★

apc RECOMMENDS

NETWORKING ACCESSORY

$125 | WWW.TP-LINK.COM.AU

TP-Link TL-PA8010P Kit

Supercharged wired-networking made easy.

Thanks to the rise of video streaming, powerline networking adapters have seen a recent resurgence, but the faster models all suffer the same drawback: the wall-plug adapters are so large they'll eclipse the neighbouring outlets on either side of any socket they're plugged into.

Very much aware of this, Aussie company Netcomm Wireless was the first to market with a 600Mbps powerline adapter that offers a power-passthrough socket, so you can have at least one more usable outlet. But that NP507 Netcomm adapter is a little pricy and notably slower than true Gigabit offerings, so we were intrigued to see how TP-Link's new TP-PA8010P adapter set would stack up.

The TP-PA8010P is a similar size as the NP507, but rather than extending laterally, TP Link's unit protrudes downwards. This stops them from taking over multiple sockets, like the NP507 – although the trade-off is that they won't work in power sockets close to the ground or just above a bench. Over a short distance, the TL-PA801P was able to get the same scores as the fastest Gigabit powerline adapter kit we've tested, netting 296Mbps down and 264Mbps up, which smashed the NP507's 146Mbps and 123Mbps short-distance scores. In longer distance testing (over older townhouse wiring), it had impressive speeds of 124Mbps down and 96Mbps up, a result that more than doubled the Netcomm scores.

Considering this is reasonably priced and has socket-passthrough, it's hard not to be impressed by this little kit. ■ Joel Burgess

Verdict

A well-priced powerline unit that keeps up with the fastest on the market.

★★★★½

SECURITY SERVICE

$14.5 PER MONTH SUBSCRIPTION | WWW.CAMMY.COM/AU

Cammy Wi-Fi Home Security System

Is a security subscription sCammy?

We buy most of our tech outright, with the option to pay for any relevant ongoing services after that left open. Cammy is a new security company that believes a cloud-based security system involving IP cams is worthy of a subscription service. While it makes sense to provide a service that will keep your security footage in the cloud, depending on the system you set it up with, the cost can sometimes outweigh the benefit.

Cammy pitches itself as a smart security camera that will only capture the motion of humans. It manages this by running data from heat sensors and camera visuals through analytics software, which determines if movement patterns were made by people. For this reason, Cammy is as much an advanced motion detection system as it is a security camera. Which is fortunate, because, as an indoor internet-connected security camera, Cammy's basic Penguin IP cam model has a couple of limitations. Though it has a respectable 1.3MP resolution, unless you're looking at the live feed, Cammy won't save video, deferring instead to a series of images for the duration of movement.

Despite the Cammy app having all the mainstay components (a live feed page, saved file segment and an alarm option hub), the app is a little light when it comes to settings, locking down picture quality and lacking any arming schedule options.

So while the underlying alarm service might be worthwhile, it's a pity the IP camera and app components are a little underwhelming. ■ Joel Burgess

Verdict

A good motion detection system, but there are better security cameras out there.

★★★½☆

GAMING MOUSE

$99 | WWW.RAZERZONE.COM

Razer Orochi Chroma

A diminutive mobile mouse aimed at the gaming market.

Razer is best known for its dedicated gaming peripherals, but it has a bit of a sideline in mobile-oriented products such as this Orochi mouse. Aimed at laptop users, it's actually fairly light on gaming features: it connects through either Bluetooth or wired USB – the latter via a detachable 90cm braided cord which slots into the mouse's base below the scroll wheel.

Its ambidextrous design offers two thumb buttons on either side and a nicely-sized, rubberised ratched wheel, and while there's an 8,200dpi laser sensor, there's no on-the-fly DPI switching, or even a Bluetooth pairing button for that matter (you need to press down all four side buttons to activate pairing mode).

The rubber grips on the sides make it stable in the hand and a dedicated power button on the bottom, plus a robust little carry bag mean it's easy travel with.

It uses two AA batteries for power, which results in a bit too much junk in the trunk for our liking – it's back-heavy, which isn't overly comfortable in this smaller design if you're a fingertip or claw-style mouse gripper. It's a little better if you prefer to rest the bridge of your palm on the top – but this is a very compact mouse lengthwise, so resting your palm on the back will generally place your fingers too far forward.

The mouse included with Razer's new Turret lapboard (see page 40) is physically almost identical to the Orochi, but it uses a rechargable battery, so the weight is far better balanced.

That said, our favourite mobile mouse is still the Logitech MX Anywhere 2. It weighs 103g vs the Orochi's 111g, but that weight is nice and evenly distributed – you can find it for around $90 on the street. ■ Dan Gardiner

Verdict

Unevenly distributed weight undermines what would otherwise be an appealing laptop mouse.

★★½☆☆

MECHANICAL GAMING KEYBOARD

$169.95 | WWW.ROCCAT.ORG

Roccat Suora Frameless Mechanical Keyboard

Maximum functionality in an ultra-minimal package.

Gaming keyboard design doesn't come any simpler than this. Roccat has taken the already no-frills design of minimalist gaming keyboards and gone further with the Suora, stripping off all the extraneous plastic and the key housing too.

What you're left with is essentially a slab of aluminium alloy with Cherry Brown-switched keys sitting proudly on top. Like a naked motorbike, its styling is equal parts utilitarian, menacing and beautiful. Though it'll eat up 12.5cm x 42cm of desk space, the Suora's frameless design masks its size and makes it almost feel like a tenkeyless.

On the feature front, the Suora boasts 1,000Hz polling, N-key rollover, 11 lighting modes, six macro keys (nested with the Home bank), as well as the ubiquitous F/media bank along the top.

The frameless design means that loads of light floods from beneath the keycaps (which may vex lovers of precise, per-key lighting schemes) but we loved how it accentuated that floating key feeling.

Getting the Suora up and running was a little more trouble than it should have been. We needed to trundle off and download and install Roccat's Swarm driver suite before our PC even recognised the Suora – without Swarm, it simply blinked infuriatingly without recognising key inputs. Teething aside, the Suora is a fantastic mechanical board once it's up and running, and coupled with Swarm – which manages your gaming profiles, lighting setup and macros all in one place – gaming and general typing is comfortable, natural and hassle-free.

■ Troy Coleman

Verdict

Some setup issues, but once mitigated, the uber-minimal Suora is a delight to repeatedly touch.

★★★★½

GAMING MOUSE

$120 | BLUEMOUTH.COM

Ozone Neon 3K

It's Spanish for 'click'.

You might be reading the name Ozone for the first time, but this Spanish PC-peripherals manufacturer has been slugging it out since 2009 – it's only now that its gear is starting to make its way down under.

The Ozone Neon 3K is an ambidextrous optical gaming mouse. It's fairly light on the feature front, focusing on pin-accurate mousing up to 3,500dpi with a polling rate of up to 1,000Hz. There are eight programmable OMRON-switched buttons (including the mirrored thumb buttons), a ratcheted rubber scroller, 128KB memory, six LED colours to choose from, and a generously long braided USB cable.

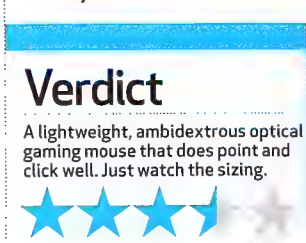
Comfort and efficient use of the Neon 3K is really going to come down to hand size and, as with all mice, we don't recommend a purchase without first getting it into your greasy little hands. At 125mm x 65mm x 36.8mm, it's really long and narrow without a lot of peak, which is fine for those of a more diminutive stature, but for this cow-flank-handed hulk of a reviewer, it's just a little small. The matte-finished rubber coating doesn't really combat this either, as it's basically built to repel dirt and grease, thus ultimately becoming slick as gaming hands become seepy. Some additonal textured kung-fu grip on the sides at the key thumb/pinky grip points – take a look at the second generation Razer Deathadder – would have been very welcome.

While the Neon 3K will happily work plug-and-play, users looking for a little more can grab the driver software online. It's fairly lightweight in terms of features but does give you the chance to remap buttons, adjust the on-the-fly dpi switch settings and also change the colour of the logo.

Troy Coleman

Verdict

A lightweight, ambidextrous optical gaming mouse that does point and click well. Just watch the sizing.



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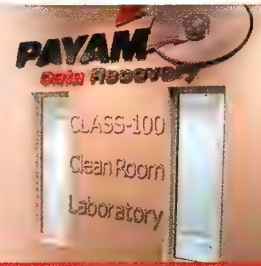

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GAMING KEYBOARD/MOUSE

$219 | WWW.RAZERZONE.COM/GAMING-CONTROLLERS/RAZER-TURRET

Razer Turret

A wireless Bluetooth laptop-and-mouse deck for living room PC gamers.

PC gaming from the couch has always been a bit awkward. I've personally been using a wired keyboard and mouse perched precariously on my lap on top of a stack of board games for the last 18 months (finally, a use for that *Star Wars* Monopoly set I bought last year!). And while couch-style gaming keyboards are out there, they've all appeared a bit too cumbersome to both use and store, and the Steam Controller isn't quite my cup of hot chocolate.

The Razer Turret, while sounding like something GlaDOS may have created for testing purposes, is a beautifully slim wireless gaming peripheral, a far cry from Razer's mechanical monsters in the BlackWidow series. It's a black matte keyboard with chiclet-style membrane keys – usefully fingerprint-resistant – highlighted with fluoro green. The keyboard doesn't have any macro keys or a numpad, but it does have a couple of dedicated Android keys, and the included symmetrical mouse has two programmable buttons down each side. The entire setup, however, means this is for right-handers only.

Out of the box, the keyboard and mouse need to be charged before use and one of the best things about this device is how this is done. The keyboard possesses an integrated magnetic mouse mat that folds backwards on a sturdy hinge, revealing the charging port. This is placed vertically, along with the included mouse, into an intelligent and unobtrusive charging dock that can be plugged into the computer via USB or straight into a power socket. This makes the whole package very conveniently sized and even looks good sitting on a shelf when not in use.

So how does it hold up in gaming situations? At a glance, the mouse mat may look a little small but, thanks to its magnetic nature, the mouse has very little chance of falling off, and you can easily get used to a change in sensitivity, meaning the mat doesn't need to be any bigger.

Due to its compact and wireless design, the whole thing is easy to pass between friends during a co-op game such as *Worms*. We experienced no problems with the wireless connectivity, and the anti-ghosting worked well, except the odd instance of typing at great speed.

Speaking of which, this is a very versatile keyboard. It's comfortable to type on at length, as well as game with, and its grippy underside ensured it sat perfectly still on the lap. However, if you're a female gamer, be prepared to adopt a rather uncouth leg-spread to get the balance just right. Men... as you were.

As a method of using a mouse and keyboard for couch-bound gaming, the Turret is almost flawless. The only thing we would have liked to have seen is some kind of backlighting for the keys, since (we assume) many people will use it in a darkened room. But that's a minor niggle, and a non-issue for anyone who can touch-type.

In all, this keyboard-mouse combo is easy to set up, charge and use; it's also comfortable, attractive and functionally fantastic.

If you want/desperately need a wireless gaming keyboard and mouse but don't like the chunkier style options that resemble full-blown tables, then we'd absolutely recommend this.

Carmel Sealey

Verdict

Features	★★★★½
Performance	★★★★½
Value	★★★★½

A great-looking and functionally fantastic peripheral for those looking to game on the couch wirelessly.

★★★★½

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venomcomputers.com.au

Available from mln.com.au/venom/blackbook

INTERNAL HARD DRIVE

US$46 | WWW.WDC.COM

Western Digital PiDrive

Building the ultimate Raspberry Pi setup means obtaining the largest amount of storage. Can the PiDrive from a major manufacturer beat microSD?

The Raspberry Pi has been with us for four years. In that time, the main storage device has been the humble microSD card, but now Western Digital has created the PiDrive, though it's not yet available in Australia at time of writing.

This is a standard 2.5-inch laptop hard drive that replaced the standard SATA connection with a native USB interface. The drive has also been tweaked to be more power efficient – a necessity when working with the Pi. We used the additional PiDrive cable kit, which contains a 2 amp power supply, and a special cable that connects the drive to the Pi USB ports for receiving and routing power from the power supply to the drive and the Raspberry Pi simultaneously. The drive is physically larger than the Pi, and there's no way to attach the drive to the Pi via mounting holes.

We tested the PiDrive with the Raspberry Pi 3 running the latest Raspbian release and from the outset saw the dreaded multicoloured square in the top-right corner of the screen – an indication of the Pi struggling for power. However, the drive and Pi worked well together and we were able to use the drive in much the same way as a typical flash drive. Being a mechanical disk and using a USB 2.0 interface is really no issue and the drive was fit for all tasks.

There's no better test than BerryBoot to put the drive through its paces. This is an application written to an SD card that can download and configure multiple operating systems to create a multi-boot device. It's very similar to the NOOBS installation system that's used by the Raspberry Pi Foundation.

Western Digital has provided a special version of BerryBoot which works with the PiDrive. The installation of BerryBoot simply requires extracting the downloaded files to a blank SD card. With the PiDrive attached and the BerryBoot micro SD card in our Raspberry Pi 3, booting up yields a simple graphical configuration tool that enables you to set up a monitor, internet connection and audio. Once the configuration is completed, you can use the menu editor to select an OS for installation on the PiDrive.

There are many OSes available, from standard Raspbian to Android (Kit Kat) and to the specialist Kali Linux distribution (distro), used for security auditing and penetration testing systems. We set Raspbian to be our default OS, rebooted, launched Raspbian and, overall, the whole boot took 20.92 seconds from BerryBoot menu selection to desktop. This is only a few seconds slower than booting directly from the SD card, which clocks in at around 18 seconds. Using Raspbian via the PiDrive feels no different to using it on an SD card, albeit we have 314GB of storage at our disposal.

The PiDrive is a clever bit of kit and for the right project it's a great asset. However, as USB flash storage increases in size while lowering in price the reasons to buy this drive are disappearing.

Les Pounder

Verdict

Features	★★★½
Performance	★★★½
Value	★★★½

A good product and should be seriously considered if you need power efficient storage in your projects.

★★★½

SMARTPHONE

$599 | WWW.OPPO.COM/AU

apc HOT PRODUCT

Oppo R9

If it looks like a duck and quacks like a duck...

We didn't think it was possible to be any more iPhone-like than Oppo's R7, R7s and R7 Plus devices, but it seems the mid-range smartphone manufacturer has narrowed the gap even further with its new R9.

Oppo has added the iOS signature feature for the R9 a physical home button with metal trim, front and centre. The R9 also has rounded iPhone 6-like edges, thinner 1.66mm side bezels and a rose gold ergonomic backplate that all add to the iPhone clone look.

Oppo has brought its higher-end forward-facing camera designs into the R range, which jumps from the 8MP of the R7s to a surprisingly good 16MP one, although the rear 13MP camera remains the same. The company is also eager to point out its inbuilt Beautify 4.0 software.

The R9 also packs 64GB of storage, a new fingerprint sensor integrated into the Home button and the next iteration of Oppo's own tweaked Android 5.1 mobile operating system Colour OS. The software has not only added a new Security Centre, a few tweaks to the settings layout and a set of updated icons, but it's also apparently more power efficient. Indeed, the R9's 2,850mAh battery knocked out the longest PCMark for Android battery benchmark we've seen, at 11:15hr.

The R9's MediaTek 2GHz octa-core CPU produces a barely discernible boost over the R7's Qualcomm 1.7GHz octa-core CPU, but the R9 gives you double the onboard storage, a better front-facing camera, better battery life, a full OS upgrade, a much slimmer and more ergonomic profile.

Joel Burgess

Verdict

An affordable new flagship from one of the better Chinese Android phone makers.

★★★★½

SMARTPHONE

$899 | CONSUMER.HUAWEI.COM

Huawei Mate 8

It's like Nexus and iPhone hooked up and had an enormous, rather unwieldy baby.

With its huge 6-inch screen and wonderful metal unibody, the Mate 8 impresses right off the bat. However, it's only after spending some time with this premium-priced phablet that its underwhelming elements start to become evident.

The screen has a 1080p resolution that looks somewhat fuzzy in comparison to pretty much any other high-end Android phone with a QHD display. Also, this screen is a little too big. The Mate's copious screen real estate means that it looks off when using anything other than Huawei's own iOS-aping Emotion UI 4.0. You could switch on the Mate 8's One-hand UI, which shrinks the screen down to either the bottom corners of the screen, but you're better off getting another phone if you want to reach everything with one thumb.

Though the Mate 8 runs Android 6.0 Marshmallow, it's nearly unrecognisable, thanks to the iPhone-inspired UI that comes set by default. That said, Huawei's phone does come with some nifty features of its own, such as knuckle gestures. They sound ridiculous, but we now wish every phone had it.

Performance-wise, the ARM CPU is on-par with the best out there. However, the Mate 8's graphics processor does leave us wanting.

More impressive is the 4,000mAh battery, which lasted over 10.5 hours in our PCMark for Android test. It sports a snappy 16MP camera on the back and a front-facing 8MP one.

The Mate 8 does many things well, but we can't recommend it over the Huawei-built Nexus 6P.

Stephen Lambrechts

Verdict

A huge phone that's not quite as appealing as Huawei's own supersized Nexus 6P.

★★★½☆

software

» APPS FOR ALL THE PLATFORMS

Windows SOFTWARE

FileMaker Pro 15

The veteran database software keeps up to date.

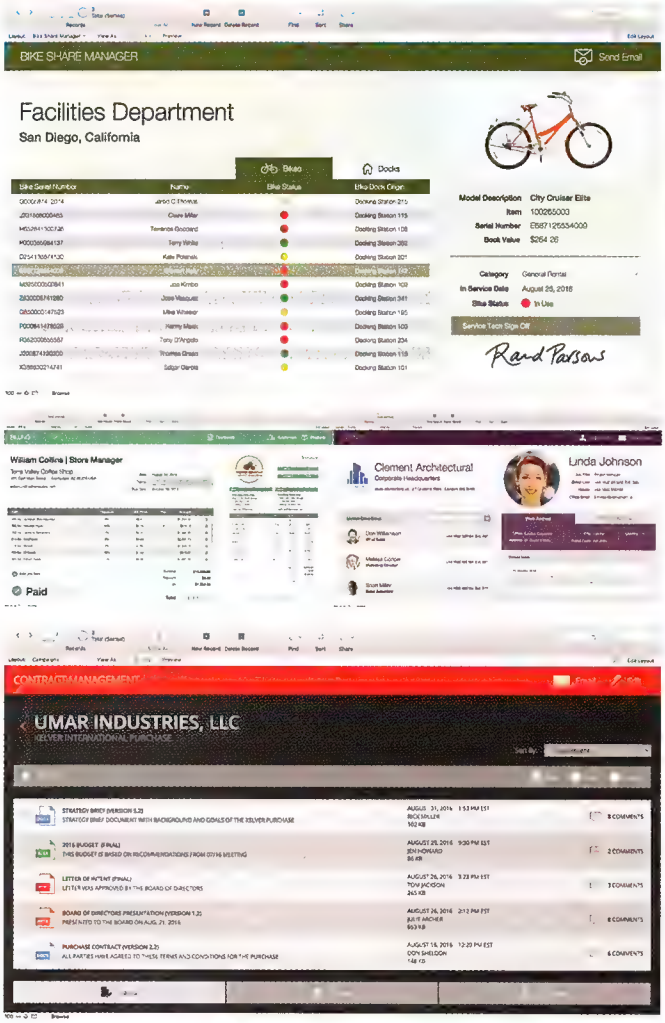
FROM $401; UPGRADE FROM FMP 12 OR NEWER, $240
WWW.FILEMAKER.COM

Although old-timers consider FileMaker to be the granddaddy of desktop database applications, over the years, the Apple subsidiary's flagship software has spread its wings and become something far more expansive.

Most of the FileMaker Pro 15 buzz is focused on performance, saving time, and small tweaks to streamline the software for new and veteran users alike. Errors are now highlighted in red from the Script Workspace, making it easier to spot problems after importing existing scripts. Pro 15's user interface has also received a few meaningful improvements, with redesigned status toolbar icons, a refreshed layout inspector and new Getting Started window. You can also use the Undo command from the script editor. And Help is now web-based, but can downloaded for offline access. Version 15 doesn't take the security of your data for granted, with the option to conceal edit boxes. Developers creating custom apps used to capture sensitive data such as PIN codes can now obscure characters from view as they're being entered.

Coming so closely on the heels of last year's more feature-packed release, many users will opt to dodge the $240 upgrade by just skipping ahead to the next version — especially when there's still no way to sync database files between desktop and mobile using a cloud service.

FileMaker Pro 15's core functionality has taken a backseat this year, but that's allowed the mobile and server enhancements to shine. **J.R. Bookwalter**



Speccy

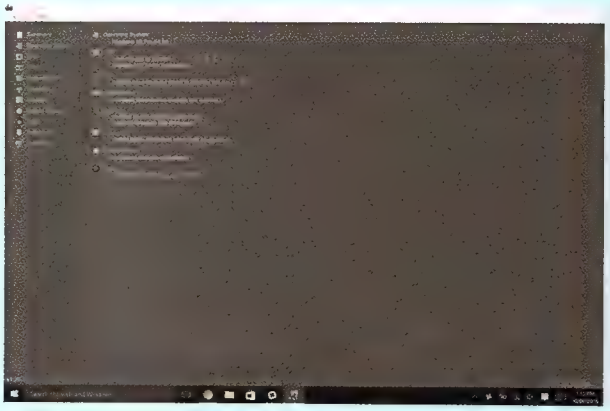
THE SUM OF THE PARTS.

FREE | WWW.PIRIFORM.COM/SPECCY

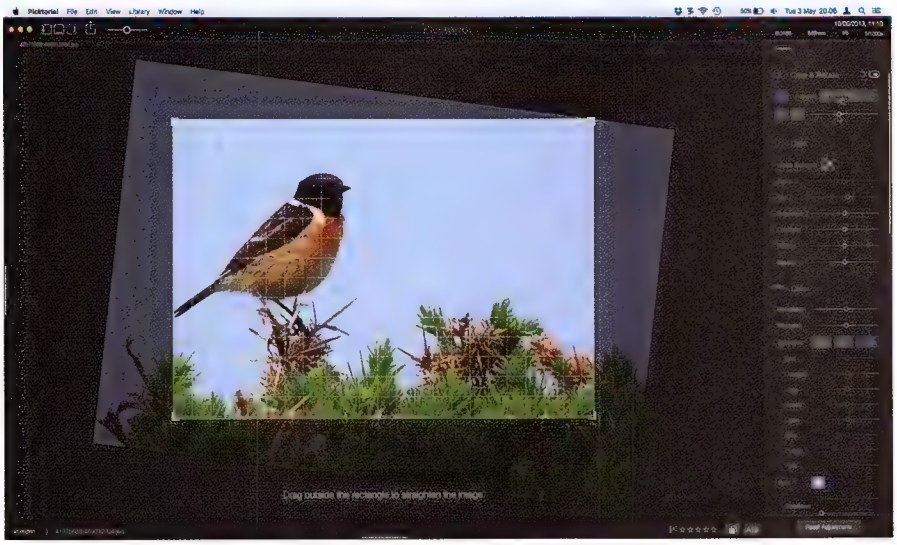
It can be handy to see all the details and specifications of your PC in one easy to navigate space. But this actually isn't such a simple thing to do for the average PC user.

Currently, CPU-Z (**www.cpuid.com**) is probably the most popular hardware cataloguing app for the more hardcore PC set, but you sometimes have to know what you're looking at or do a little further digging to get at the exact details. Speccy is a more recent program from Piriform and it makes knowing what's under the hood of your PC a little easier. The main summary interface is simple but informative, giving you details like the class of the computer's CPU and what generation of microarchitecture it is rather than just regurgitating the model number.

Furthermore, you can easily drill down into each component to find more detailed information that even



includes graphs of the current CPU temperature and total system RAM usage. This is a first-rate (and slightly less intimidating) hardware catalogue app for your PC that won't cost you a cent — definitely one to keep on hand. **Joel Burgess**



Picktorial

An impressive photo-editing app that won't completely break the bank.

$62.99 | PICKTORIAL.COM

Photo-editing apps tend to go one of two ways: you've got one-shot filter effects, such as Priime Styles, and then more Photoshop-like apps with in-depth tools for full control of editing your images. Picktorial features aspects of both.

While it's unfortunate there are no layers to work with, you do get non-destructive editing. There's also skin-smoothing, raw image file support for a growing list of cameras, white balance adjustment tools, and a curves adjustment histogram, as well as compatibility with existing Aperture catalogue files.

The interface is clean, with editing tools in an Inspector panel on the right, and file browsing on the left and below the image you're editing. Any of the side panels can be slid out of the way when you're not using them.

Photo filters aren't always to everyone's taste. Happily, Picktorial contains film-simulation filters along with its more Instagram-like ones. The bundled ones are customisable, you can create your own, and there's a always reset button nearby if things get out of hand. That's all some people will want, but this is a $63 app, so it's gratifying that it takes things further.

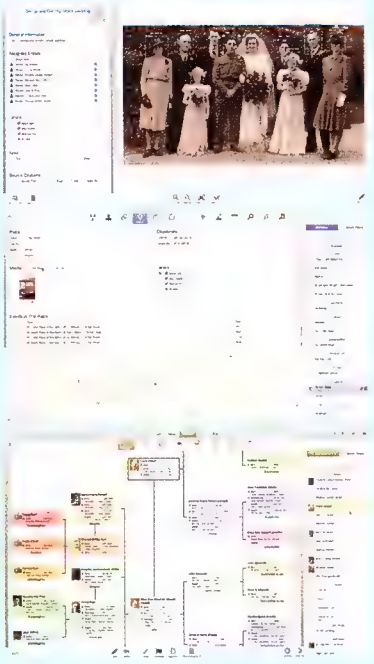
Scroll down the Inspector and you'll find tools for cropping and rotating images, Lightroom-style sliders including exposure and white balance, and some clever colour saturation settings that can alter the hue, saturation and luminosity of eight colour channels, along with a Split Tone tool for separately adjusting the colour of shadows and highlights.

Retouching options include a Tone tool that only affects a preselected region of your photo, which you define by painting. You can then adjust colour temperature, exposure, contrast and saturation over the defined area using a discrete set of sliders. It's a neat way of getting around the lack of a general selection tool, and you can paint more than one region. It takes a steady hand if you want to be accurate with your selection, though.

Overlays to add folds, cracks and frames to your images are also available, as is watermarking to protect your creations.

All things considered, Picktorial is a very good image editor. Its developer has put a lot of thought into its design and feature set, with tools that are easy to use and a simple interface. It would make a fine replacement for Aperture's editing tools, or if you don't want to pay more for (or tackle the complexity of) Photoshop Elements or Affinity Photo.

Ian Evenden



MacFamilyTree 8

BACK AT THE TOP OF THE (FAMILY) TREE

$46.99 | WWW.SYNIUMSOFTWARE.COM/MACFAMILYTREE

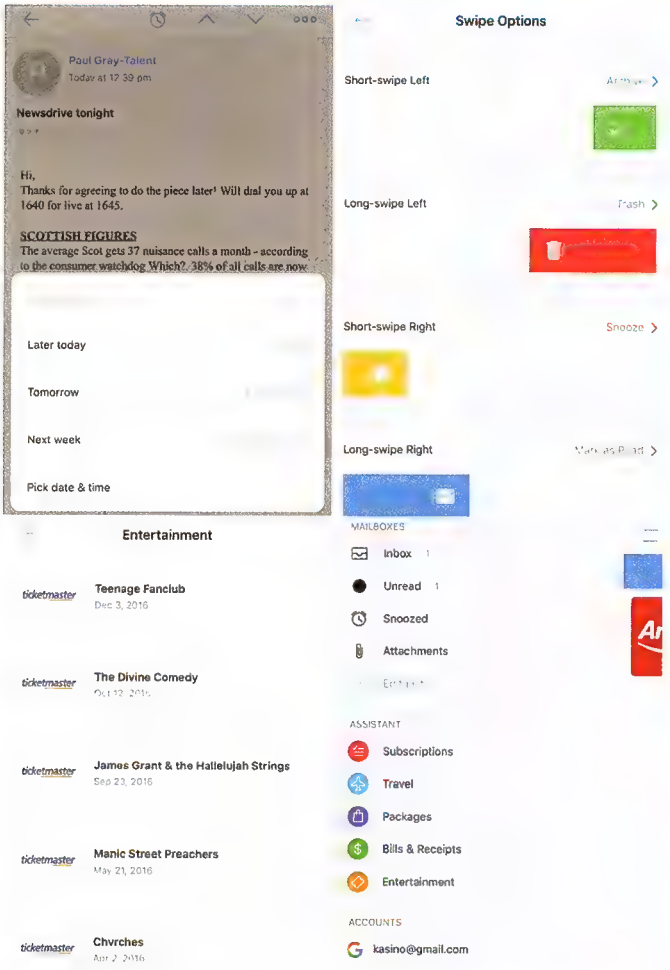
MacFamilyTree is 18 years old, so it's appropriate this latest release feels like a coming of age. The app is a complete tool for managing and publishing your family history, with all the core functionality you'd expect coupled with useful online features like iCloud syncing, the ability to share your tree online, and integration with **familysearch.org**.

Version 7 was a little disappointing, but since then, Synium Software has been busy providing free major updates to improve key areas of the app, specifically its subpar Places management tools. Street-level mapping was introduced a while back, and MacFamilyTree 8 tunes things further by adding a map to the Places screen, so you can immediately see if you've selected the right one.

Other improvements include a new Interactive Tree view, which has basic editing tools integrated into it. There's also support for custom fact types, smart filters, new Sidebar lists for browsing your database, as well as an improved editing mode.

Some minor annoyances remain but, on the whole, we have no hesitation in making MacFamilyTree our family history app of choice.

Nick Peers



EasilyDo Mail

A terribly named but superb app.

FREE | WWW.EASILYDOMAIL.COM

Since the early days of mobile email, we've been frustrated by iOS email apps: many of them are very good, but don't quite hit the spot – and the ones that came close, such as Mailbox and Sparrow, were shut down.

But now we've discovered EasilyDo Mail, which is pretty close to perfect. Exchange and iPad support isn't coming until late summer, and you'll need to wait for the next build to use Gmail aliases. However, for now, it's extremely fast — much faster on Gmail than Apple's Mail app — and it has smart Assistants that automatically find and organise purchases, tickets and travel documents. It has a unified inbox, email snoozing, Undo Send and Undo Delete, which sounds rather like Google's Inbox, but it's done so much better.

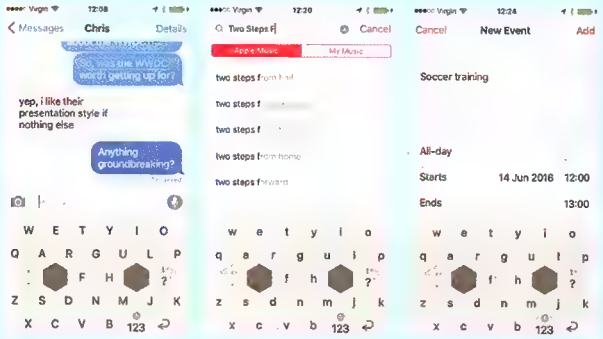
It's as good-looking as anything on iOS, it's packed with useful customisation options — including 3D Touch actions — and its Assistants are intelligent and useful. It can block email tracking and read receipts, its search makes Mail.app's search look embarrassingly slow. We're one build away from binning our existing apps and embracing EasilyDo Mail as our everyday email client. It's that good. **Gary Marshall**

WRIO Keyboard

A different way to type.

$4.49 | WRIO-KEYBOARD.COM

This is the result of a successful crowdfunding campaign from October 2015; however, the asking price of $4.49 without even a trial option may deter a large number of potential users. And this keyboard will not be for everyone, let's make that perfectly clear from the outset. It is designed primarily for people who use two thumbs to type, which I don't. Thus, during the tutorial when asked to use both of my rather large digits, I struggled — not a good sign. Once that hurdle is overcome, however, you learn how to delete (swipe left) and restore text (swipe right). Many keys have multiple characters, which you access either by tapping, swiping upwards, tap and holding, or hold and swiping. It has a personalised autocorrect dictionary on the horizon, but it would be nice if it implemented some of the basic autocorrect things now, such as capitalising 'i' and replacing 'weve' with 'we've'. While some of the gestures were immediately comfortable (such as deleting and capitalising), the layout will take getting used to. If you make lots of typos and don't mind coughing up the asking price, then you may as well give it a go. **Carmel Sealey**



Brolly

It's Strayan for umbrella, mate.

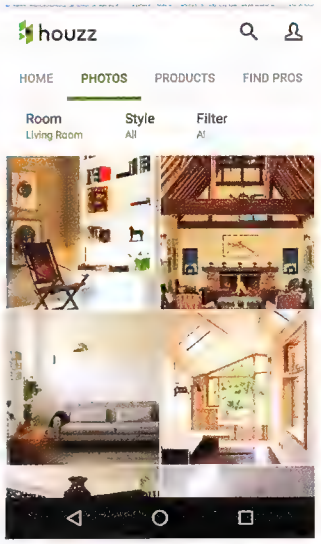
FREE WITH IAP | BROLLY.MOBI

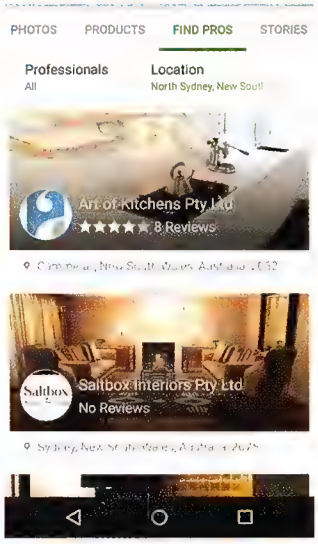
Analysing data from the BOM, Brolly determines whether or not you need an umbrella anytime soon and is very black and white about it. "No isolated showers or 20% probability, just rain or no rain soon." If you use another weather app that doesn't have hour-by-hour weather predictions, a forecast of "showers developing in the afternoon" is a bit vague. You might even resort to looking at the radar and guessing how long it will be until that bank of rain reaches you by measuring how far it's travelled in the last hour... Brolly's developers wanted to make an app that does all that thinking for you by telling you how long until you need to reach for that brumberella and even tells you how long it will be raining for. The app provides "reasonably accurate" predictions to within an hour of it raining "and really great inside half an hour", developer Alex North says. It's a shame you can't check in on locations not your own, though. **Carmel Sealey**

Houzz

Create the home you've always wanted.

FREE | WWW.HOUZZ.COM.AU





This is basically an endlessly updated edition of *Better Homes & Gardens*. If you're keen on interior design, it's a pretty useful resource: it's stuffed with decor porn, and you can browse by room and style types, as well as some other categories (metro area, budget, and so on).

Each photo can be interactive (depending on the thoroughness of the uploader), with tags attached to any relevant items or related services. So, for example, if you like the look of that outdoor dining set, chances are you can tap on it to get more details.

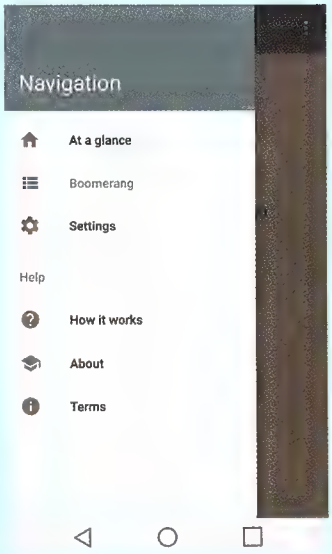
The Find Pros section is great if you're looking for upmarket interior designers and architects in your area, though at the time of writing, the Products menu was restricted to results for purchases based in the United Kingdom. That's a small hit against an otherwise pretty spectacular app – and it's likely to change over time. But if living in the pages of an IKEA catalogue is something that appeals to you, Houzz will help you achieve that goal.

Shaun Prescott

Boomerang Notifications

FREE | TINYURL.COM/APC431-BOOM

This management app enables you to save a notification after you've dismissed it. After installing, you're prompted to select which of your apps you wish Boomerang to oversee. When a notification appears, you deal with it as per usual, but when it's dismissed, Boomerang's own alert takes its place, asking whether you would like to save that notification or not. If not, the unobtrusive Boomerang notification will disappear after ten seconds (this can be changed in settings). If you do wish to save it, that notification will be *Boomerang'd* and will appear in a list in the app rather than your notifications drawer — meaning you can pretend you have a clear to-do list. You can also view your upcoming reminders together in one clean and attractive app. While some online have complained about the app draining battery life and lagging, we had no such issues. This service has the potential to be valuable to those drowning in notifications, but for those on top of everything... perhaps not. **Carmel Sealey**

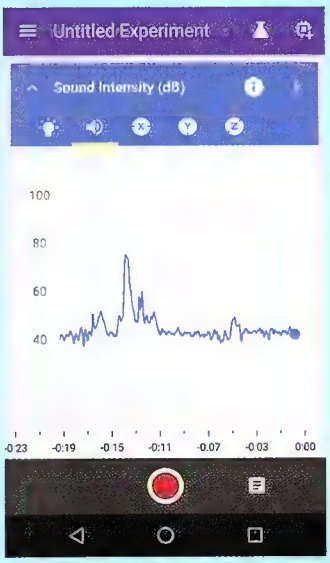


Google Science Journal

FREE | SCHOLAR.GOOGLE.COM

This is an interesting app that allows you to conduct your own science experiments using a smartphone. At first, it seems a little limited: using sensors and other features in your phone, it can measure ambient light, sound intensity and it has an accelerometer on the X, Y and Z axes. That's fine, but so bloody what? Measuring the decibels in a room isn't going to excite anyone for long, but it's about how you use the tools at hand that matters, which means you're going to need to use (take a deep breath) some initiative and imagination. For example, it's possible to measure how the intensity of your daily run might diminish over time, using the stats offered by the accelerometer. When you approach it this way, it's pretty nifty, and since it's really geared towards getting younger folk interested in science, it's best considered a learning tool, or a toy, even though it's undoubtedly capable of many practical uses.

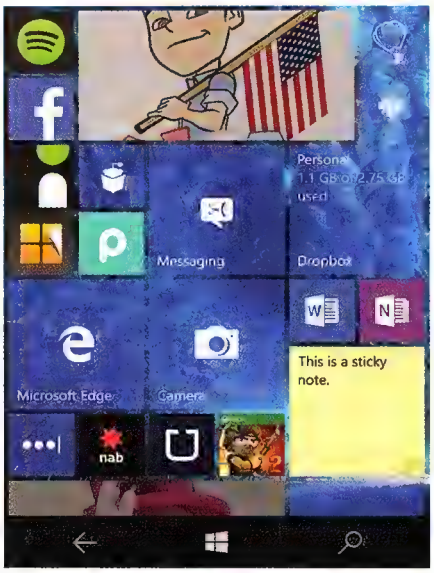
Shaun Prescott



Live Stickies

Stick post-its on your screen.

FREE | TINYURL.COM/APC431-STICK



Though we didn't realise it until we found this app, your Windows phone home screen basically looks like a well-manicured pinboard that contains a mosaic of your favourite apps and settings. Adding directly to this concept, Live Stickeys is a note-taking app that allows you to pin reminders, to-do lists and notes directly to your Windows Phone's home screen so you'll never miss a note again.

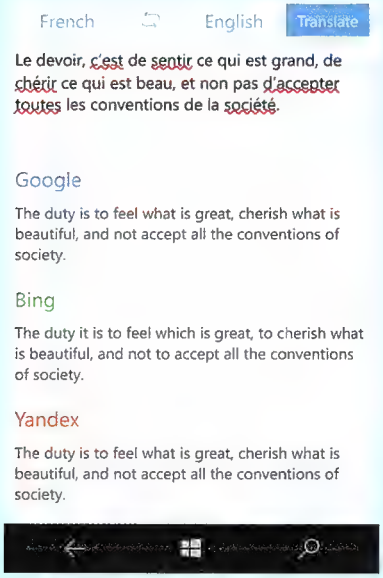
Much like your normal home page tiles, Live Stickies notes can be resized in either small squares, big squares or banners, and though the smallest will just have a squiggle image replacing your text, the other two sizes allow you to read the note without having to tap through to it. You can attach as many notes as you want to the title page, but you only have the option to use the one text size and font and there aren't any colour options for the post-it notes themselves either. But for a free app, it's worth it to make do with what is there.

Joel Burgess

Combo Translator

FREE | TINYURL.COM/APC431-COMBO

If you've ever read multiple translations of a book written in a foreign tongue, you'll be aware how much the interpretation of a particular dialect can vary depending on who (or what) is translating the language. Most of the time, you can get a functional understanding of a piece of foreign text by simply running it through free software like Google Translate, but if you need a more subtle understanding of what's been written, it's worth checking it with a few sources, to see when there are differences between the translations. Combo Translator draws on translations from Google Translate, Bing Translator and Yandex Translator to give you a reasonable set of interpretations in one easy-to-use place. For the most part, all three translations are inconsequentially different with the more common latin-based tongues — but there are hundreds of available languages that the tool translates, which can throw up much bigger variations. If you need to translate literature or dense text as closely as possible, then this app could serve as a simple (and free) first step.


French
English
Translate
Le devoir, c'est de sentir ce qui est grand, de chérir ce qui est beau, et non pas d'accepter toutes les conventions de la société.
Google
The duty is to feel what is great, cherish what is beautiful, and not accept all the conventions of society.
Bing
The duty it is to feel which is great, to cherish what is beautiful, and not to accept all the conventions of society.
Yandex
The duty is to feel what is great, cherish what is beautiful, and not accept all the conventions of society.

Joel Burgess

Mirror's Edge Companion

FREE | WWW.MIRRORSEDGE.COM/MAP

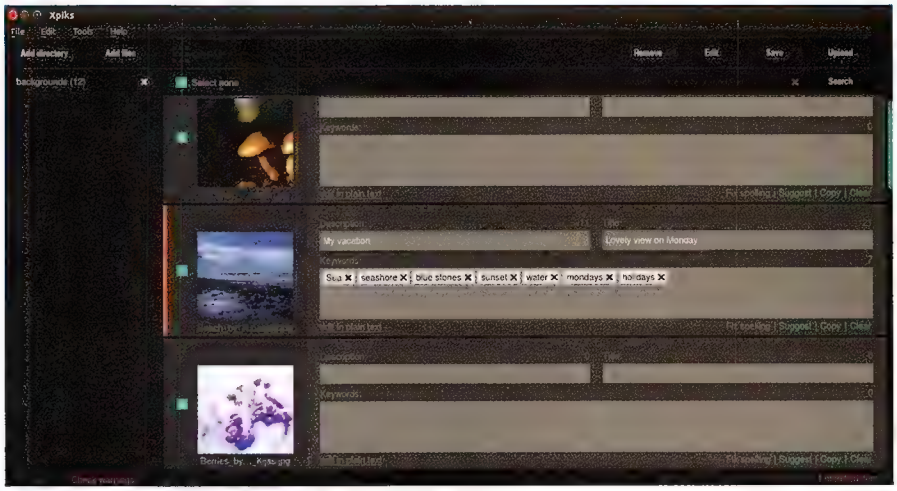
One of the biggest developments in the recent *Mirror's Edge* sequel (*Catalyst*) is that it's now technically an open world game, and in such setups, mini-maps can be crucial navigation aides. The devs behind *Mirror's Edge* have clearly recognised this fact and developed a Companion app for Android, iOS and Windows mobiles that allows you to look at a map of the game's world directly on your handset. After signing in with an EA account, players can see their character's progress, 'Runners Beats' and time trial markers sprawling through the 3D satellite image-like map of *Catalyst*'s City of Glass. In addition to the mini-map, the companion app will also let you tweak your runner's emblem (which is displayed on the hacked billboards in the game) and keep a running log of all time-trial battles between you and a friend to entice a bit of friendly competition. If you're looking for more from the *Mirror's Edge* world, then this well-designed Windows mobile app is an excellent free offering.

Joel Burgess

Xpiks

Keywording like a pro.

FREE | RIBTOKS.GITHUB.IO/XPIKS



Photography enthusiasts will be aware that an image collection requires regular sorting and tagging to remain clean and logical. Once you stop caring about your photo collection, it soon becomes troublesome to find that precious needle of a memory inside your directory's virtual haystack. Enter Xpiks, a photography focused application that has little to do with classic photo organisers.

With Xpiks, you can add keywords to your images and upload them to a remote host. Nothing new? Well, Xpiks is different and here is why.

First off, it's quite strict in forcing you to keep your tags tidy and correct. For each image, Xpiks will require you to fill in the Description, Title and Keywords and you can't just opt to write random text, because Xpiks has a built-in checker that helps you avoid common mistakes (or lazy cheats).

By default, Xpiks wants you to add at least seven keywords and more than two words for both the description and title fields. Additionally, the words in the title aren't allowed to match keywords. This might drive some users up the wall, in which case this application isn't for you, but it will mean that you'll create a tightly catalogued image collection. You can edit multiple images by selecting them and pressing the 'Edit' button on the top bar and when you're done with tagging and keywording, you just press 'Upload'.

Xpiks doesn't have any integration with image services on the internet, what it does is specify FTP credentials of remote host and upload your work to it. The project website offers few binaries for Linux systems, namely these are Deb and RPM packages.

We would recommend that you read the installation instructions provided, because Xpiks needs extra Qt5-related libraries to run and work – strangely these are not included in packages' dependencies. However, once you install the application correctly, it will run smoothly and quickly.

Alexander Tolstoy

Smartmontools

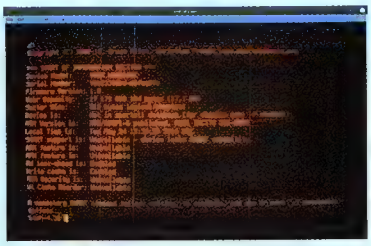
FREE | WWW.SMARTMONTOOLS.ORG

We're all aware that drives tend to fail after prolonged use, but you can hardly predict a failure without any feedback from components. Hard disk monitoring firmware was introduced by IBM in 1992 for its IBM 9337 Disk Arrays for AS/400 servers, but it took significantly longer for the self-monitoring, analysis and reporting technology (SMART) to reach the majority of consumer-grade hard drives.

In Linux, you can retrieve that sort of information using Smartmontools, a specialised toolset for inspecting ATA/SATA and SCSI/SAS hard drives and SSDs. It consists of the 'smartctl' utility and 'smartd' daemon, which both play similar roles but in different manners. With smartctl, you can perform certain actions on demand while smartd runs in the background and delivers live reports.

If you're dealing with an ageing device that might die at any moment, smartctl can detect its state before it is too late. In other words, you'll have some precious hours to make a backup copy of your data.

Alexander Tolstoy



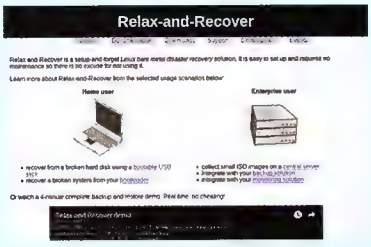
Relax and Recover

FREE | RELAX-AND-RECOVER.ORG

It's hard to dispute that doing regular snapshots of your precious data is a good idea. Another point of concern is your Linux system itself. All extra repositories — tips, tweaks and updates that you've made after your initial installation— are as valuable.

Relax and Recover (REAR) is a backup automation tool that's designed to create regular snapshots of your Linux system. These snapshots are bootable and installable — ie. with REAR, you can quickly create live ISO images of your current system. This offers the obvious benefits of being able to boot from backup ISO and use a live installer to quickly deploy your system anywhere.

REAR isn't unique, there's a somewhat similar technology in Pinguy OS, an Ubuntu-based distro that enables you to create your own Linux remix and include everything you want inside of it. But REAR is a tool from the world of Red Hat and Fedora and not Ubuntu. It has many advanced options and enables you to create custom configs, add REAR to cron and perform automatic backups etc. **Alexander Tolstoy**



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KILLER GPUs COMPARED
New GeForce GTX 1070s & 1080s rounded-up
GEFORCE GTX
HANDS-ON HOW-TO
BUILD A BULLETPROOF PC
CREATE AN UNBEATABLE NEXT-GEN DESKTOP THAT'S READY FOR VR, 4K, DEV WORK & MORE!
EXPERT KNOW-HOW MADE EASY
How to fix and enhance photos in Linux
Learn the 10 habits of effective coders
Personalise Cortana in Windows 10
HOTTEST NEW TECH REVIEWED
Thinnest-ever laptop: HP's new Spectre tackles Apple head on
Intel NUC for gaming: The ultimate living room ready mini-PC?
Keyboard & mouse from the couch? New lapboards make it so!
AMD MAKES VR CHEAPER
New Radeon promises VR-ready performance for just $330. Does it actually deliver?
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HANDS-ON HOW-TO

BUILD A BULLETPROOF PC

CREATE AN UNBEATABLE NEXT-GEN DESKTOP THAT'S READY FOR VR, 4K, DEV WORK & MORE!

With the recent launch of Intel's Broadwell-E CPUs and Nvidia's simultaneous unleashing of its GTX 1080 and 1070 graphics cards, now's just about the perfect time to build a top-shelf PC. Throw a next-generation SSD into the equation – many of which are capable of reaching sustained read and write speeds of over 2,000MB/s – and you've got a PC that's basically bulletproof; it'll handle everything from VR to 4K gaming to high-end rendering work.

While going for this top-end gear is certainly not cheap, it's not quite as unreasonable as you might expect. Intel's entry-level Broadwell-E (the six-core Core i7-6800K), for example, can be had at $680 – making it far, far more affordable than the top end i7-6950X, which will set you back an eye-watering $2,580. Throw in $400 for the motherboard, $800 for a graphics card, $500 for an NVMe SSD and a couple hundred for some DDR4 and you'll be able to assemble a system for around $2,500.

And if that's too dear, don't fret – we'll look into some more affordable VR-ready options in an upcoming issue soon!

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Killer GPUs: GTX 1080 & 1070 graphics cards compared

Lindsay Handmer tests ultimate graphics cards for 4K, VR and beyond.

The latest Nvidia GPUs are finally here, and offer some compelling performance over older models. The new Pascal architecture is available in both the GTX 1080 and GTX 1070 models, with some differences between the two. The top dog GeForce GTX 1080 has 2560 CUDA cores, 8GB of GDDR5X RAM and a base/boost clock frequency of 1,607/1,733 MHz. The GeForce GTX 1070 strips things back a little, with 1920 CUDA cores, a 1,506MHz base clock, 1,683MHz boost clock and 8GB of GDDR5 RAM.

The more powerful GTX 1080 gives very high framerates on the latest games at 1080p, and has the grunt to maintain playability at 1440p and 4K without needing to drop the detail levels. The GTX 1070 is similarly aimed at 1080p and 1440p gaming, and can comfortably run many titles at 4K, especially if the details are dropped back. The 1080 and 1070 support DirectX 12, though compatible games are still fairly rare. Both the cards are also ready for VR gaming, once the gear is actually readily available.

To put it in perspective, the GTX 1080 is up to about 30% more powerful than the Titan X, and 50%+ better than the GTX 980. The GTX 1070 is on par with the older Titan X (for half the price) and easily bests the GTX 980.

We tested the GPUs with a range of synthetic and gaming benchmarks at different resolutions as a performance comparison. We tested with Windows 10 Pro, a Core i7-6900K, 16GB of Kingston HyperX DDR4 RAM, ASUS Strix X99 Gaming motherboard, Thermaltake heatsink, CoolerMaster PSU and a Samsung 950 Pro SSD.

$1,200 | WWW.ASUS.COM/AU

Max Frequency: 1,936 MHz; 8GB GDDR5X RAM; dual-slot form factor; 6-pin + 8-pin power; Aura RGB lighting

ASUS ROG Strix GeForce GTX 1080

Are you ready for VR?

Not content with the basic stock performance, the ASUS boffins have also overclocked the 2560 CUDA cores straight out of the box. By default, the card runs in Gaming Mode, which raises the base clock up to 1,759MHz, and the boost clock to 1,898MHz. OC Mode goes further, with a 1,936MHz boost clock and a 1,784 base clock. The card also has 8GB of GDDR5X memory and has both a six-pin and an eight-pin power connector. Consumption is rated at up to 300W for the card alone, so a 600W+ PSU is needed, pending exact spec.

The result is excellent performance, which is more than capable enough for most modern games at both 1080p and 4K resolutions. The ASUS cooling solution uses triple fans mounted over a direct contact heatsink, which remains pretty quiet even under full load. The GPU also has its own fan headers which can directly control case fans based on GPU temp.

The card also has the same Aura RGB Lighting that many of the motherboards enjoy, which offers custom colour and effect selection.

On the business end, the 1080 offers both dual-HDMI and DisplayPort, plus DVI.

ASUS also GPU Tweak II, which makes it simple for beginners to get extra performance from their videocard, as well as options for more advanced users.

The ASUS GTX 1080 measures in at 298mm x 134mm x 40mm, and includes two Velcro cable management loops plus a dual six-pin to eight-pin power connector in the box.

Verdict

Excellent performance and features, especially considering the price.

★★★★☆

$1,259 | WWW.GIGABYTE.COM.AU

Max Frequency: 1,936MHz; 8GB GDDR5X RAM; dual slot form factor; dual 8-pin power; VR dual-HDMI front panel

Gigabyte GeForce GTX 1080 Xtreme

Overclocked for your gaming pleasure.

In an effort to stand out, as well as provide some extra value, the Gigabyte GeForce GTX 1080 comes with a tasty VR-focused treat. Included is the Xtreme VR Link 5.25-inch front panel, which sports 2x HDMI and 2x USB 3.0. This makes it simple to plug in a VR headset, without needing to get behind the PC. It also automatically detects and switches from the existing connectors upon reboot. In normal mode, the card has 3x DisplayPort, HDMI and DVI. In VR mode, it swaps to dual front HDMI ports, plus DisplayPort, HDMI and DVI around the back.

Not content with stock frequencies, the Gigabyte GPU runs an 1,898MHz boost clock and 1,759MHz base clock in gaming mode. For extra performance, OC mode pushes that up to a base of 1,784MHz, and a boost clock of 1,936MHz, as well as a 10,416MHz memory clock.

The GPU uses an interesting triple overlaid fan setup, plus heatsink, which Gigabyte claims improves cooling. In our testing, it remained fairly quiet even under load. It also has customisable RGB lighting, plus LEDs that warn if the supplied power is not stable.

Not surprisingly, considering the high-end OC, the Gigabyte card offered excellent performance across the board. The beefed-up fans and heatsink do mean the card is a little thicker than the competition (but still dual slot), and measures in at 289mm x 138mm x 56mm. It does need dual eight-pin power connectors though, and comes with a dual six-pin to eight-pin adaptor.

Verdict

Top-notch performance with an extras bundle that will appeal to VR users.

★★★★☆

$1,139 | AU.MSI.COM

Max Frequency: 1,847 MHz; 8GB GDDR5X RAM; dual slot form factor; 6-pin + 8-pin power; RGB LED lighting

MSI GeForce GTX 1080 Gaming X 8G

Is it time to game in 4K?

The MSI GeForce GTX 1080 Gaming X 8G card comes factory overclocked, with two boosted modes – OC and Gaming – as well as a Silent Mode that uses the stock frequencies. In OC mode, the 1080 can hit 1,847MHz when boosting and has 1,708MHz base clock. OC mode also boosts the RAM from 10,010MHz up to 10,108MHz. While not the absolute top performer of the cards tested, the MSI offering can handle modern games at 1080p and 4K resolutions, not to mention VR.

Rather than the stock cooler, MSI has upgraded to a twin ball-bearing fan system, with a large TWIN FROZR heat pipe cooler. Under load, the card is somewhat audible, but is very quiet under light loads and can even run passively. It also has built-in RGB LEDs, with customisable colours and patterns.

The card itself measures in at 279mm x 140mm x 42mm, and weighs 1,100g. It's specced at 180W of power consumption, so a beefy PSU is needed. The card uses both the six-pin and eight-pin power connectors. Round the back end, it has three DisplayPort connections, a single HDMI port and DVI.

The videocard also includes the MSI Gaming App, which allows you to further overclock the GPU, as well as offering a one-click setup feature for VR readiness. It even has an Android app which allows GPU control via a smartphone or tablet.

Also included is MSI Dragon Eye, which allows YouTube or Twitch streams to be watched while gaming, plus XSplit Gamecaster for creating your own.

Verdict

Excellent performance backed up with a great software bundle.

★★★★½

$830 | WWW.ASUS.COM/AU

Max Frequency: 1,860MHz; 8GB GDDR5 RAM; dual slot form factor; 8-pin power; Aura RGB LED lighting

ASUS ROG Strix GTX 1070 08G Gaming

Overclocked and ready to game.

In an effort to stand out, the ASUS GTX 1070 has a custom triple fan cooling solution, with a large direct contact heatpipes and radiator underneath. The card also includes the ASUS Aura RGB LED lighting system, which can be customised in terms of colours and patterns.

The ASUS GPU pushes the overclock further than any other GTX 1070 tested, with a maximum boost of 1,860MHz and a base clock of 1,657MHz in OC mode. You need to enable this in GPU Tweak II, though, as the card defaults to the still very fast Gaming mode, with a 1,632MHz base clock and a 1,835MHz boost clock – which is still faster than the competition.

Performance is excellent across the board, and maintains a small lead on the tested competition. The card also still remains quiet when gaming, and can scale back to a completely passive zero noise mode under light load. The 1070 also includes two four-pin fan headers on the GPU itself, which can be used to directly control system fans based on videocard temperature.

The card uses a single eight-pin power connector, but doesn't include any adaptors in the box. Round the back, the card sports different outputs to its brethren – dual HDMI and dual DisplayPort (plus DVI), vs the usual triple DisplayPort, HDMI and DVI, which aims to make it more VR friendly.

While the ASUS GTX 1070 is noticeably faster than the other 1070s tested, it's also more expensive. Pricing is still very new, so keep an eye on it over time.

Verdict

The top performing 1070 tested, albeit for a bit of a price hike.

★★★★½

$769 | WWW.GIGABYTE.COM.AU

Max Frequency: 1,822MHz; 8GB GDDR5 RAM; dual slot form factor; single 8-pin power; RGB LED lighting

Gigabyte GeForce GTX 1070 G1 Gaming

Does your PC need an upgrade?

For those craving high-end gaming performance, without a totally overtop price tag, Gigabyte has released their take on the GeForce GTX 1070. No surprises, the card is overclocked – in gaming mode, the G1 Gaming takes the base clock to 1,594MHz, while the boost clock hits 1,784MHz. Pushing the card even further, it hits 1,620 MHz base clock and an 1,822MHz boost frequency. The memory trundles along at 8,008MHz. The end result is a very capable card that is more than powerful enough for the latest games, even at 4K resolutions.

The G1 Gaming also gets a custom aftermarket cooler, with triple fans and a large heatsink and composite heat pipes. Even under load, it stays impressively quiet, and can bring the fans to a complete halt at idle. The GPU also has RGB LEDs, plus smart indicators that show if the power supply isn't stable. The included Xtreme software makes it easy to adjust the lighting, or select from the OC modes. You can also get hands on and monitor temps, or tune the card yourself.

Round the back end, the Gigabyte card sports three DisplayPort connections, plus HDMI and DVI, and can run four monitors.

It only needs a single eight-pin power connector, though a 500W PSU is recommended. The whole card measures in at 280mm x 114mm x 41mm. Aside from the GPU itself, the offering is pretty bare, with just a driver CD and printed quick start guide – no dual six-pin to eight-pin power adaptor, though.

Verdict

A very capable GPU with a healthy factory overclock helping to tackle the latest games.

★★★★☆

$759 | AU.MSI.COM

Max Frequency: 1,797MHz; 8GB GDDR5 RAM; dual slot form factor; 6-pin + 8-pin power; RGB LED lighting

MSI GeForce GTX 1070 Gaming X 8G

Do you need bang for buck gaming?

Opting for the top dog GPU is all well and good, but for those who want a slightly more affordable option, the NVIDIA GeForce GTX 1070 has some compelling advantages. Like its bigger brother (see far left), the MSI GeForce GTX 1070 Gaming X 8G is factory overclocked for extra performance.

In the 'silent' mode, the card runs at stock frequencies, while Gaming Mode has a 1,582MHz base clock and a 1,771MHz boost clock. OC Mode takes things a step further, with a 1,607MHz base clock and a 1,797MHz boost clock. The memory also sees a boost in OC Mode, up to 8,108MHz. The result is excellent gaming performance that can rip through the latest games and have a good crack at 4K resolutions as well. The card is also powerful enough for VR, without the higher price tag of the 1080.

The MSI 1070 uses the same Twin FROZR VI cooling solution as the 1080, with large twin fans over a chunky heatsink. It can run completely silently (with fans stopped), but even under heavy load, the card is very quiet.

The MSI card features three DisplayPort connections, as well as HDMI and DVI. In this case, though, it can run four displays, and is VR and SLI ready. The GPU measures in at 279mm x 140mm x 42mm, and weighs 1,100 grams. It needs both a six-pin and an eight-pin power connector, as it is rated at 150W power consumption.

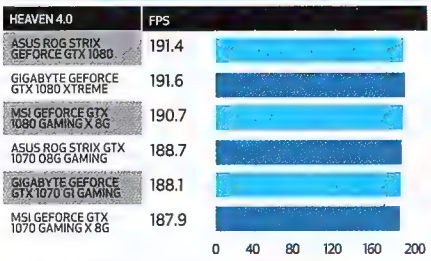
The MSI GPU also has RGB LEDs, and comes with software such as Gaming App, as well as a Android app for separate control.

Verdict

A more affordable gaming solution that still packs some serious gaming grunt.

★★★★☆

LABS BENCHMARK RESULTS


HEAVEN 4.0
FPS
ASUS ROG STRIX GEFORCE GTX 1080 191.4
GIGABYTE GEFORCE GTX 1080 XTREME 191.6
MSI GEFORCE GTX 1080 GAMING X 8G 190.7
ASUS ROG STRIX GTX 1070 O8G GAMING 188.7
GIGABYTE GEFORCE GTX 1070 G1 GAMING 188.1
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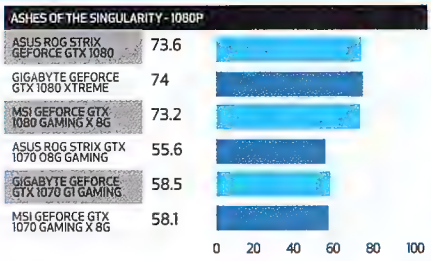
ASHES OF THE SINGULARITY - 1080P
ASUS ROG STRIX GEFORCE GTX 1080 73.6
GIGABYTE GEFORCE GTX 1080 XTREME 74
MSI GEFORCE GTX 1080 GAMING X 8G 73.2
ASUS ROG STRIX GTX 1070 O8G GAMING 55.6
GIGABYTE GEFORCE GTX 1070 G1 GAMING 58.5
MSI GEFORCE GTX 1070 GAMING X 8G 58.1
0 20 40 60 80 100

HITMAN
(DX12) 4K
ASUS ROG STRIX GEFORCE GTX 1080 47.1
GIGABYTE GEFORCE GTX 1080 XTREME 47.8
MSI GEFORCE GTX 1080 GAMING X 8G 47
ASUS ROG STRIX GTX 1070 O8G GAMING 37.9
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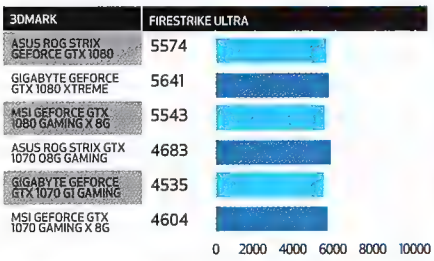
3DMARK
FIRESTRIKE ULTRA
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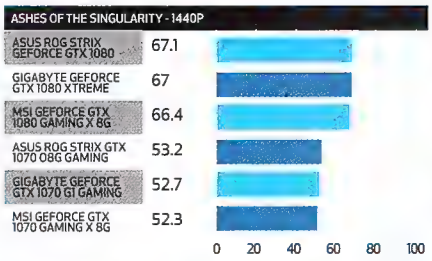
ASHES OF THE SINGULARITY - 1440P
ASUS ROG STRIX GEFORCE GTX 1080 67.1
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MSI GEFORCE GTX 1080 GAMING X 8G 66.4
ASUS ROG STRIX GTX 1070 O8G GAMING 53.2
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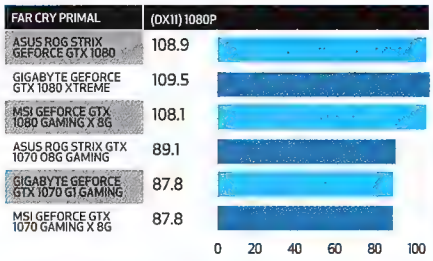
FAR CRY PRIMAL
(DX11) 1080P
ASUS ROG STRIX GEFORCE GTX 1080 108.9
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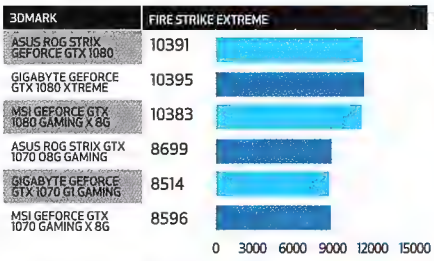
3DMARK
FIRE STRIKE EXTREME
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GIGABYTE GEFORCE GTX 1080 XTREME 10395
MSI GEFORCE GTX 1080 GAMING X 8G 10383
ASUS ROG STRIX GTX 1070 O8G GAMING 8699
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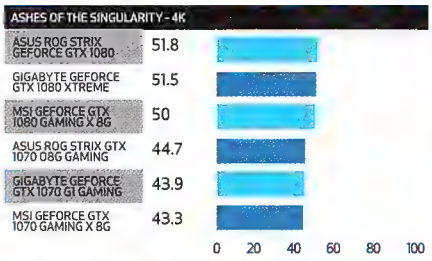
ASHES OF THE SINGULARITY - 4K
ASUS ROG STRIX GEFORCE GTX 1080 51.8
GIGABYTE GEFORCE GTX 1080 XTREME 51.5
MSI GEFORCE GTX 1080 GAMING X 8G 50
ASUS ROG STRIX GTX 1070 O8G GAMING 44.7
GIGABYTE GEFORCE GTX 1070 G1 GAMING 43.9
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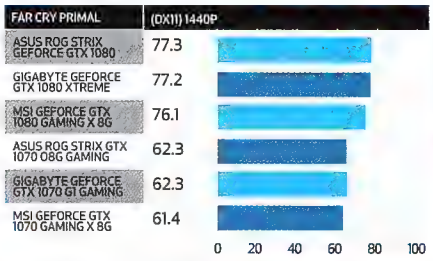
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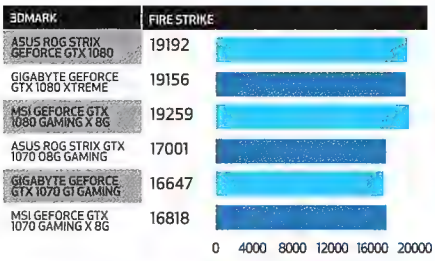
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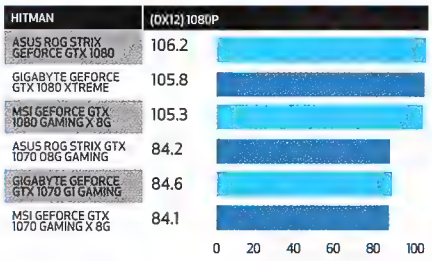
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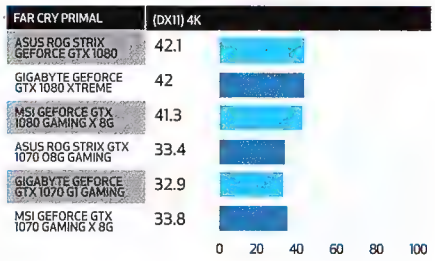
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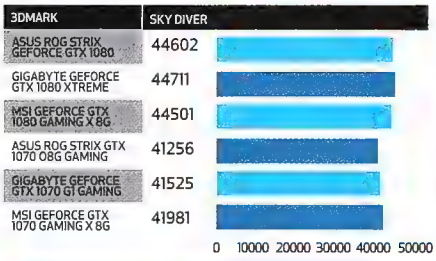
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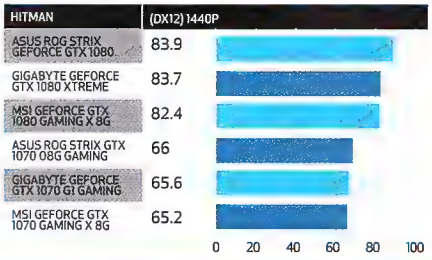
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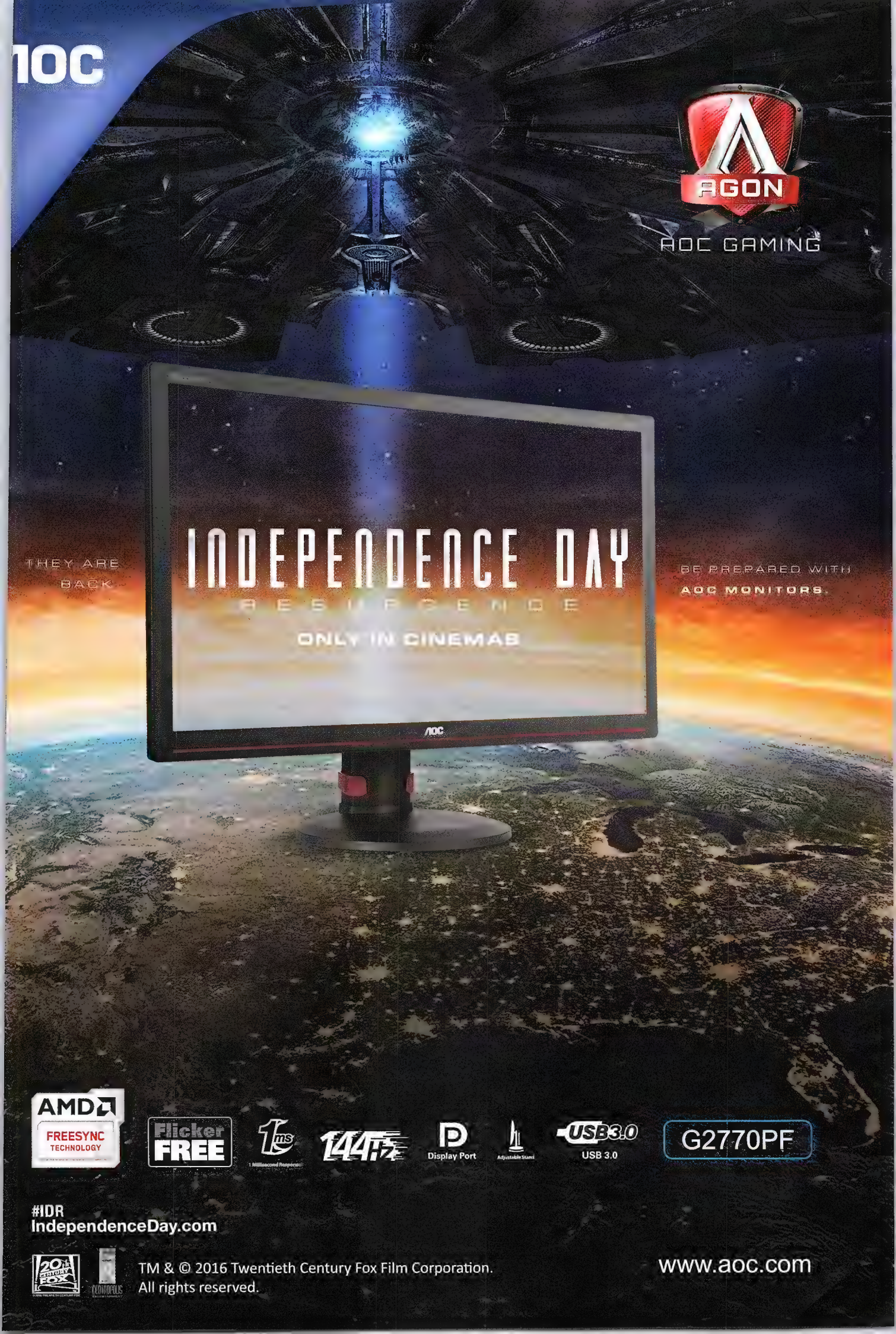
ASUS ROG STRIX GTX 1070 O8G GAMING 66
GIGABYTE GEFORCE GTX 1070 G1 GAMING 65.6
MSI GEFORCE GTX 1070 GAMING X 8G 65.2
0 20 40 60 80 100

TABLE HEADLINE

	PRICE	MAX FREQUENCY	DIMENSIONS	FORM FACTOR	OUTPUTS	POWER	SOFTWARE	POWER ADAPTORS	EXTRAS
ASUS ROG STRIX GEFORCE GTX 1080	$1,200	1,936 MHZ	298 X 134 X 40MM	DUAL SLOT	2X HDMI, 2X DISPLAYPORT, DVI	6-PIN, 8-PIN	GPU TWEAK II	DUAL 6-PIN TO 8-PIN POWER ADAPTOR	AURA RGB LEDS, FAN HEADERS
GIGABYTE GEFORCE GTX 1080 XTREME GAMING PREMIUM PACK	$1,259	1,936 MHZ	289 X 138 X 56MM	DUAL SLOT	3X DISPLAY-PORT, HDMI, DVI	DUAL 8-PIN	XTREME ENGINE	DUAL 6-PIN TO 8-PIN POWER ADAPTOR	VR HDMI FRONT PANEL
MSI GEFORCE GTX 1080 GAMING X 8G	$1,139	1,847 MHZ	279 X 140 X 42MM	DUAL SLOT	3X DISPLAY-PORT, HDMI, DVI	6-PIN, 8-PIN	MSI GAMING APP, DRAGON EYE, XPLIT GAMECASTER	NONE	RGB LEDS
ASUS ROG STRIX GTX 1070 O8G GAMING	$830	1,860 MHZ	298 X 134 X 40MM	DUAL SLOT	2X HDMI, 2X DISPLAYPORT, DVI	8-PIN	GPU TWEAK II	NONE	AURA RGB LEDS
GIGABYTE GEFORCE GTX 1070 G1 GAMING	$769	1,822 MHZ	280 X 114 X 41MM	DUAL SLOT	3X DISPLAY-PORT, HDMI, DVI	8-PIN	XTREME ENGINE	NONE	RGB LEDS
MSI GEFORCE GTX 1070 GAMING X 8G	$759	1,797 MHZ	279 X 140 X 42MM	DUAL SLOT	3X DISPLAY-PORT, HDMI, DVI	6-PIN, 8-PIN	MSI GAMING APP	NONE	RGB LEDS


AOC
AGON
AOC GAMING
THEY ARE BACK
INDEPENDENCE DAY
RESURGENCE
ONLY IN CINEMAS
BE PREPARED WITH AOC MONITORS.
AMD
FREESYNC
TECHNOLOGY
Flicker FREE
1ms
144Hz
Display Port
Adjustable Stand
USB3.0
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IndependenceDay.com
20th CENTURY FOX
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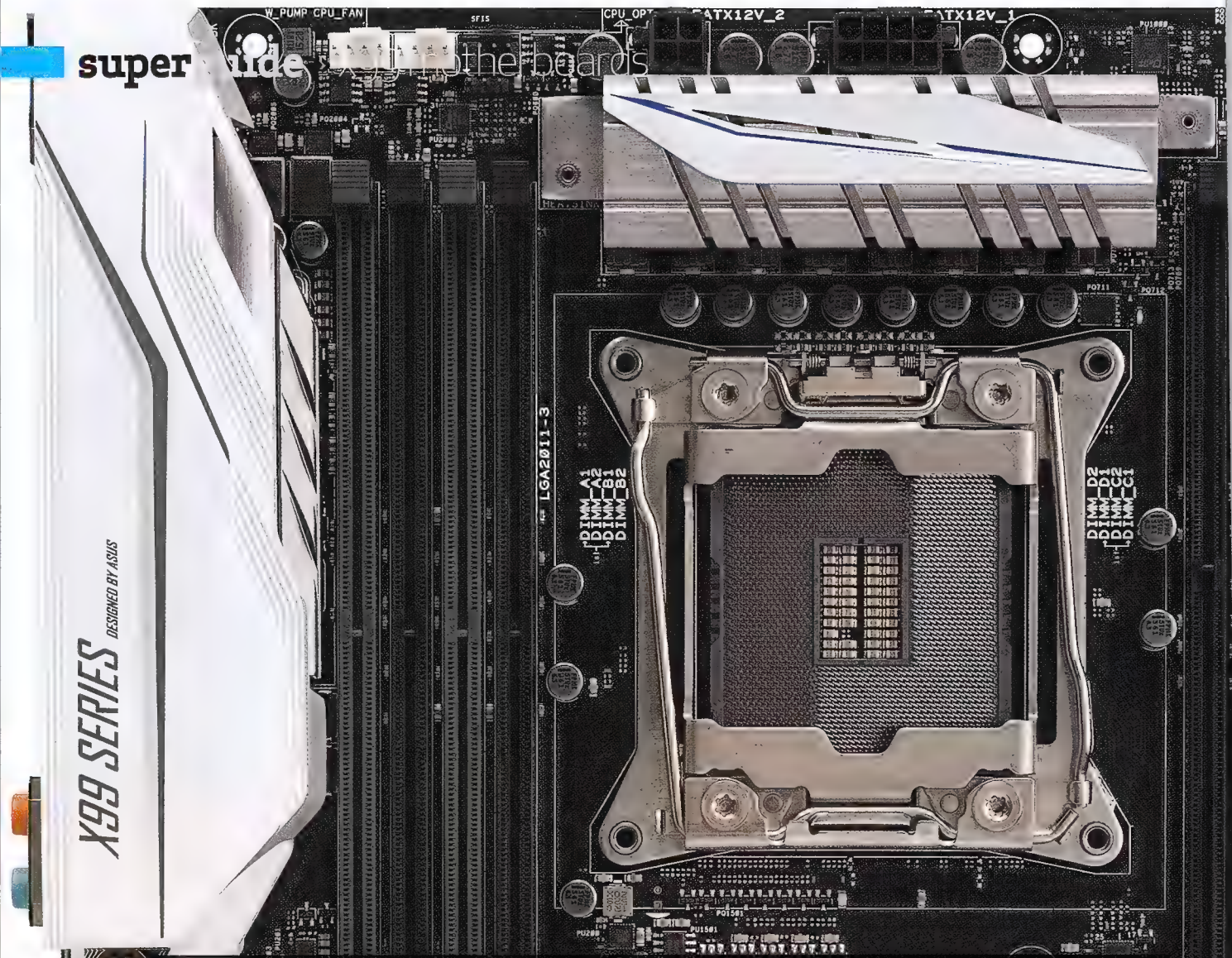
www.aoc.com



Monster motherboards: Intel X99 Gen 2 on test

Lindsay Handmer compares beastly motherboards for building a bulletproof system.

Intel has just released their latest CPU update – Broadwell-E – with a range of new CPUs. The most powerful is the i7-6950X, a 10-core monster that can boost up to 3.5Ghz. There is also a range of lesser processors with fewer cores – the i7-6900K (8-core, 3.7GHz), 6850K (6-core, 3.8GHz) and 6800K (6-core, 3.6GHz). They all use the existing LGA2011-3 socket and X99 chipset and have a 140W TDP. The CPUs support 128GB of RAM, at faster speeds than the older Broadwell CPUs. They also support Intel Turbo Boost Max Technology 3.0, which can identify and boost your best performing core over the others.

To take advantage of this, many motherboard manufacturers have released new X99 boards. Many existing boards also support the new CPUs via BIOS update. To find out how the new crop of X99 boards perform, we tested a range from different manufacturers, using an Intel Core i7-6950X. We also averaged our previous scores using the i7-5960X as a comparison. We paired the CPU with 16GB of Kingston HyperX DDR4, an ASUS Strix GeForce GTX 1080 and a Samsung 950 Pro SSD. Getting more than about a 4GHz overclock with Broadwell-E needs water or high-end air cooling, but all the boards tested handled a mild boost without an issue.

Performance across the boards tested is quite close, so it's more important to compare features and price. All the models tested feature M.2 for high-speed SSDs, but other options such as dual M.2 for RAID, or U.2 connections are available.

$465 | WWW.ASROCK.COM

Max 128GB DDR4 3,300MHz; dual M.2 PCIe x4; 3x PCIe x16; 802.11ac Wi-Fi; USB 3.1 A and C; Creative SoundBlaster Cinema3

ASRock X99 Gaming i7

A Professional FATAL1TY board.

The latest in X99 motherboards from ASRock, the Gaming i7 doesn't yet have an official price in Australia. The board handles the latest Broadwell-E CPUs, and has three PCIe x16 slots (plus two PCIe 2.0) that supports both three-way CrossFireX and SLI. The Gaming i7 can take up to 128GB of 3300MHz (OC) DDR4 RAM, spread across four channels and eight dimms. Storage is an interesting mix, thanks to dual M.2 PCIe x4 slots, which support RAID (and NVMe) for ultra-fast data rates, as well as being backwards compatible with SATA SSDs. While there is no U.2, the board does have ten SATA III connections, and SATA Express, for all those normal drives.

As expected, the Gaming i7 is more than proficient at getting the most from your desired CPU, GPU, RAM and storage. It's also OC-ready, and happily took our CPU to 4GHz, and has plenty of room for large coolers, as well as a dedicated water-cooling pump header.

Round the back, the motherboard has dual Intel Gigabit LAN ports, plus a dual band 802.11ac Wi-Fi card with Bluetooth 4.0. USB is well catered, with 3.1 spec Type-A and C ports and four USB 3.0 ports. It also has dual USB 2.0 connections, plus a legacy PS/2 port.

The ASRock motherboard features quality 7.1 channel audio with S/PDIF output, using the Realtek ALC1150 audio codec and Creative SoundBlaster Cinema3.

The board also comes with decent bundled software, such as macro creators and live streaming.

Verdict

Excellent performance and features, especially considering the price.

★★★★☆

$390 | WWW.ASROCK.COM

Max 128GB DDR4 3,300MHz; dual M.2 PCIe x4; 3x PCIe x16; 802.11ac Wi-Fi; USB 3.1 A and C; Purity Sound 3

ASRock X99 Taichi

Do you need a slightly cheaper option?

Choosing a motherboard can be tricky, with loads of features you don't actually need jacking up the price. In an effort to give wider appeal, ASRock has produced the X99 Taichi, which offers slightly cut-down features compared to the Gaming i7, for a cheaper price. The two boards look quite different thanks to the colour scheme and covers, but not a lot has changed underneath.

In fact, the biggest difference is fewer USB ports. The Taichi still has USB 3.1 Type-A and Type-C ports, but drops down to three USB 3.0 connections on the rear, but adds an extra USB 2.0, for a total of three. Another four 2.0 ports and two 3.0 ports are available via internal header, too.

The Taichi cuts back on the audio, slightly. It still uses the Realtek ALC1150 codec, but has a lesser implementation that supports Purity Sound 3, rather than Creative SoundBlaster Cinema3. In practice, the difference in quality is not noticeable, but there are a few less features.

The rest of the Taichi is top notch, though, with three PCIe x16 slots that handle SLI and CrossFireX, as well as support for up to 128GB of 3300 MHz (OC) RAM across eight slots. You also get dual M.2 (handling PCIe x 4 and SATA) with can run in RAID, plus SATA Express and ten SATA III connections, but no U.2. It also has dual Gigabit LAN, and dual band 802.11ac Wi-Fi.

In terms of raw performance, the Taichi is on par with the more expensive Gaming i7.

Verdict

An almost unnoticeable step down in spec saves decent money without sacrificing performance.

★★★★☆

$600 | WWW.ASUS.COM/AU

Max 128GB DDR4 3,333MHz; PCIe x4 M.2 / U.2; 2x2 802.11ac Wi-Fi; USB 3.1 A and C; SupremeFX Audio; AURA RGB Header

ASUS ROG Strix X99 Gaming

Craving all the bells and whistles?

For those wanting to get the most out of their new Intel Core i7-6950X, the ASUS STRIX X99 Gaming has what it takes. The socket 2011-v3 board not only accepts the latest CPUs – it can handle a massive 128GB of DDR4 3,333MHz (OC) RAM, across eight DIMMs and quad channels. It's got three PCIe 3.0 slots (plus three PCIE 2.0), which support two- and three-way SLI and CrossFireX, for multi-GPU fun.

For storage needs, the X99 Gaming has a M.2 Socket 3, which can handle 2242–22110 drives – though only in PCIe, not SATA M.2. It also has a U.2, for PCIe 3.0 x4 NVMe drives, plus SATA Express and eight SATA 6Gb/s ports for more standard drives.

As expected from higher-end boards these days, the X99 Gaming includes dual-band 802.11ac Wi-Fi with an external antenna, as well as Bluetooth 4.1. It also has Gigabit LAN, USB 3.1 in both Type-A and Type-C, as well as a gaggle of USB 2.0 and 3.0 ports. Audio is handled by ASUS SupremeFX, with eight channels and optical output. Sound quality is excellent, thanks in part to high-end components, such as Japanese capacitors.

The board also possesses the very cool AURA RGB controller, which makes it super easy to plug in a standard LED strip and control it via software.

As you would expect from a high-end board, the X99 Gaming has no problem getting the best from our test processor and SSD.

Verdict

A pricey board that delivers top-notch performance and features

★★★★☆

$470 | WWW.ASUS.COM/AU

Max 128GB DDR4 3,333MHz; PCIe x4 M.2 / U.2; Intel Gigabit LAN; USB 3.1 A and C; Realtek 1150 Audio; AURA RGB Header

ASUS X99-A II

Is it worth opting for a slightly cheaper option?

Compared to the very high-end STRIX X99 Gaming (cast your eyes left), the X99-A II offers a compelling set of features, for significantly less money. One of the biggest changes is the lack of built-in 802.11ac Wi-Fi and Bluetooth – which, while handy, isn't exactly essential, especially for those who use the Gigabit LAN port instead.

The X99-A II also has a very slight downgrade in audio (that isn't noticeably different for most users), with Realtek ALC1150 eight-channel setup, which includes optical out.

The good news is that the X99-A II is still packed full of high-end features, such as both a M.2 and U.2 PCIe x4 socket, as well as SATA Express and 8x SATA 6Gb/s connection that handle RAID. The board accepts up to eight DIMMs (128GB max) of 3,333MHz (OC) DDR4, with quad-channel architecture. It's also got the OC Socket version of 2011-v3, with extra pins for better voltage regulation. The board has plenty of room round the CPU socket as well, making it easy to install large air and water coolers.

The drop in price doesn't herald a drop in performance or usability either, and the ASUS board performed well across the board. It even includes extras such as the handy AURA controller, which makes it easy to plug in standard RGB LED strips and control them via your operating system.

Round the back, the X99-A II has both Type-A and Type-C USB 3.1 connections, as well as eight of both USB 3.0 and 2.0.

Verdict

Solid features and performance for a more affordable price.

★★★½☆

$520 | WWW.GIGABYTE.COM.AU

Max 128GB DDR4 3,600MHz; PCIe x4 M.2 / U.2; 4x PCIe quad GPUs; 2x2 802.11ac Wi-Fi; USB 3.1 A and C; Realtek 1150 Audio

Gigabyte X99-Phoenix SLI

A good mix of the stuff you'll need.

The latest Gigabyte board to support the new Intel Broadwell-E CPUs, the X99-Phoenix, is an interesting mix of features. Like its competition, the board supports 128GB of DDR4 across eight slots and four channels.

Impressively, though, it can handle frequencies up to 3,600MHz, through overclocking. The ATX form factor motherboard has four PCIe x16 slots (though two run at x8), which support quad SLI and CrossFireX.

Storage is handled by an M.2 PCIe x4 slot (which can't handle SATA), a U.2 connector, SATA Express, as well as ten SATA 6Gbps connections.

As is becoming more and more popular with high-end motherboards, the Phoenix includes built-in dual-band 802.11ac Wi-Fi, as well as Bluetooth v4.2. It's also got dual Intel Gigabit LAN ports, which can be teamed up for extra throughout.

Round the back, the board has USB 3.1 available via either USB-A or USB-C, six USB 3.0 (plus four more via internal headers) and a legacy PS/2 connection. Excellent quality audio is provided by the Realtek ALC1150 codec, with 7.1 channels and S/PDIF output.

To add a little bling to your next build, the Phoenix SLI has an array of customiseable LEDs across the board, plus a header to control LED strips.

The X99-Phoenix stands proud when it comes to performance, and it happily ekes out the best performance from your other hardware. The board can also handle a 4GHz OC just fine, and has plenty of room for large coolers.

Verdict

Solid value for those who crave high-end features and performance.

★★★★☆

$800 | AU.MSI.COM

Max 128GB DDR4 3,400MHz; PCIe x4 M.2 / U.2; 5x PCIe quad GPUs; 2x2 802.11ac Wi-Fi; USB 3.1 A and C; Realtek 1150 Audio

MSI X99A Godlike Gaming Carbon

A pricey board that's like no other.

When building the ultimate gaming PC, sometimes you just have to go all out. The MSI X99A Godlike Gaming Carbon may well be crazily expensive (well, gods are not cheap!), but it does pack in enough high-end features to make it (almost) worthwhile.

For a start, it's an oversized e-ATX form factor, which gives a bit more room for large coolers. It also means the board squeezes in five PCIe 3.0 x 16 slots, so can handle four-way SLI and CrossFireX setups. This MSI board also has dual Killer E2400 Gigabit LAN ports, for the ultimate high-speed network connection.

The rest of the board is a little more normal, but still pushes the boundaries. It can handle up to 128GB of 3,400MHz (OC) RAM, across eight slots and four channels. The M.2 slot can handle PCIe x4, as well as SATA drives, and there is also a U.2 connection.

Round the back, the board has built-in 2x2 802.11ac Wi-Fi and Bluetooth 4.0, thanks to a Killer Wireless 1535 module. It can actually work in tandem with the wired LAN, giving a total of up to 2,867Mbps throughput.

Audio quality is excellent, using the Realtek ALC1150 Codec, with 7.1 channels and S/PDIF output. For headphone lovers, there is even a dedicated 6.35mm gold-plated output.

The motherboard also has a range of extra shielding (such as on the RAM), and a customisable lighting system.

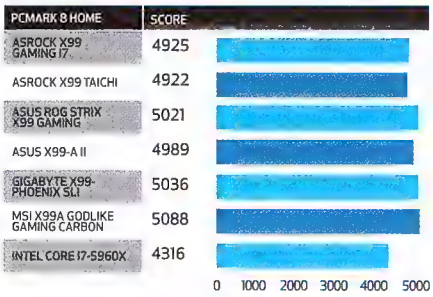
As expected, the MSI board also performs extremely well across the board, and won't disappoint power users.

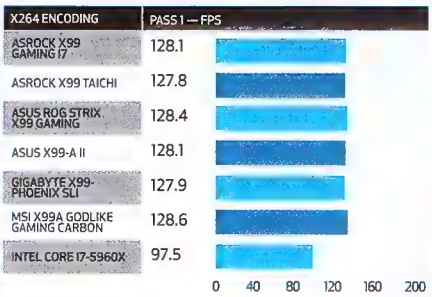
Verdict

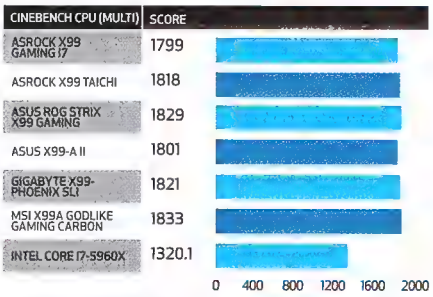
An eye watering price for a feature set you won't find anywhere else.

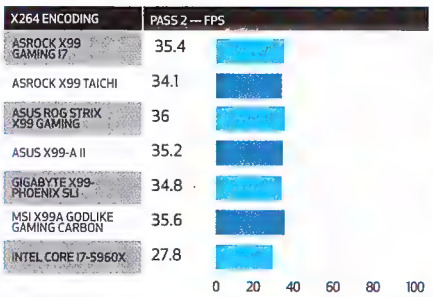
★★★★☆

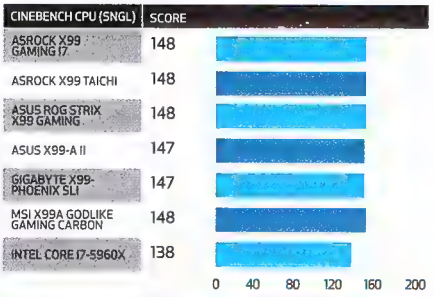
LABS BENCHMARK RESULTS

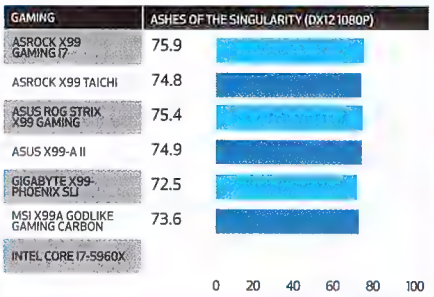






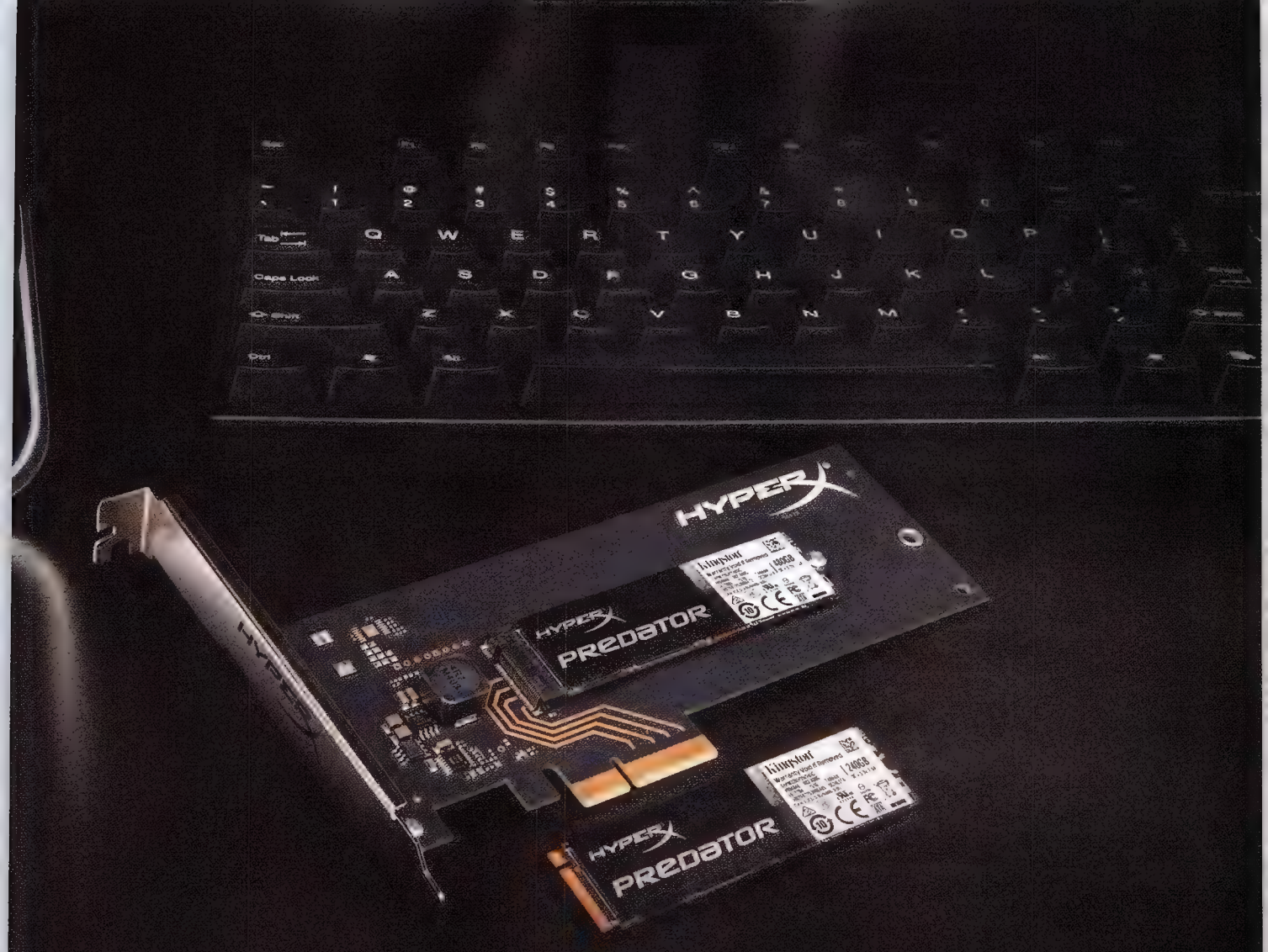






X99 MOTHERBOARD SPECIFICATIONS

	PRICE	RAM	PCIE	STORAGE		MULTI GPU	USB 3.1	AUDIO
ASROCK X99 GAMING I7	$465	128GB DDR4 3300 MHZ	3X PCIE 3.0	DUAL M.2	802.11AC	SLI / CROSS-FIREX	USB 3.1 A, C	CREATIVE SOUNDBLAST-ER CINEMA3
ASROCK X99 TAICHI	$390	128GB DDR4 3300 MHZ	3X PCIE 3.0	DUAL M.2	802.11AC	SLI / CROSS-FIREX	USB 3.1 A, C	PURITY SOUND 3
ASUS ROG STRIX X99 GAMING	$600	128GB DDR4 3333MHZ	3X PCIE 3.0	M.2 / U.2	802.11AC	SLI / CROSS-FIREX	USB 3.1 A, C	SUPREME FX
ASUS X99-A II	$470	128GB DDR4 3333MHZ	3X PCIE 3.0	M.2 / U.2	NO	SLI / CROSS-FIREX	USB 3.1 A, C	REALTEK 1150
GIGABYTE X99-PHOENIX SLI	$520	128GB DDR4 3400MHZ	4X PCIE 3.0	M.2 / U.2	802.11AC	SLI / CROSS-FIREX	USB 3.1 A, C	REALTEK 1150
MSI X99A GODLIKE GAMING CARBON	$800	128GB DDR4 3400MHZ	5X PCIE 3.0	M.2 / U.2	802.11AC	SLI / CROSS-FIREX	USB 3.1 A, C	REALTEK 1150



Fiendishly-fast SSDs

Lindsay Handmer asks: is it time for an NVMe SSD upgrade?

SSDs are a great way to boost system performance, but there are some important considerations when picking a new drive. The SATA interface is fine for older systems, but the latest motherboards and laptops have M.2 connections. Importantly, these (can) use the PCIe standard (x2 or x4) for better performance, though SATA M.2 also exists and is (mostly) best avoided. SSDs can also slot directly into a PCIe slot – a great albeit slightly bulkier option for systems without M.2.

But there is another point of performance difference amongst drives using the PCIe interface. Older drives use the same interface spec as SATA drives – AHCI (Advance Host Controller Interface), which is optimised for older, slower HDDs. NVMe (Non Volatile Memory Express) is designed as a higher speed, lower overhead interface for high speed drives, which improves performance over AHCI. Importantly, though, motherboards need to support booting from NVMe, so check before upgrading. Some NVMe SSD models (such as the Intel 750 series) also use the U.2 connection, which provides PCIe x4 over a special cable supported by some motherboards. Other options such as SATA Express do exist, but are not commonly used.

Benchmark sequential speeds show maximum transfer rates, while 4K Random read and writes show performance for accessing many small amounts of data from all over the drive, such as when booting up. Aside from raw performance, we also looked at the price in dollars per GB of storage, which gives an easy metric of 'bang for buck'.

$TBC | WWW.APACER.COM

Capacity: 240 / 480 GB; **Controller:** Phison PS5007-11; **Interface:** PCIe 4x; **Size:** M.2 2280; **Endurance:** Not specified; **Warranty:** 3 years

Apacer Z280

Can this brand new drive compete?

The current crop of ultra-fast PCIe M.2 SSDs all launched last year, and other manufacturers have been slow to catch up. One of the first alternatives available is the Apacer Z280, which was announced at Computex in June. At the time of testing, it isn't yet on sale, but will be available late July.

The Apacer Z280 uses the M.2 form factor, and communicates via PCIe x4. It also uses NVMe, for the fastest possible access speeds. The drive is available in both 240GB (as tested) and 480GB capacities. The drive uses Toshiba NAND, as well as a Phison PS5007-11 controller. Apacer has not given an endurance rating, but like most SSDs, it will be more than capable of handling normal day-to-day use long-term.

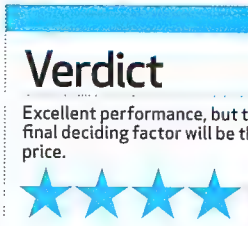
The Z280 is pretty unassuming to look at, but offers decent speeds. In testing, we managed a peak sequential read of 1,954MB/s, and writes of 955MB/s. 4K random reads and writes were also excellent, at 45MB/s and 132MB/s, respectively. To put those results in perspective, it easily beats the slower PCIe x2 drives using AHCI.

Of course, the higher-end SSDs do manage to beat the Z280, but only by a slim margin. We tested the 240GB model, and the 480 likely gives slightly improved speeds.

In the end, it all comes down to price, but at the time of writing, Apacer has not released the RRP. Still, if it can undercut the competition even slightly, the Z280 will be a compelling purchase.

Verdict

Excellent performance, but the final deciding factor will be the price.



$629 | WWW.INTEL.COM

Capacity: 400GB, 800GB, 1.2TB; **Controller:** Intel CH29AE41AB0; **Interface:** PCIe x4; **Size:** 2.5", 15mm thick; **Endurance:** 70GB per day; **Warranty:** 5 years

Intel 750 Series U.2

Is this a better connection option?

The Intel 750 series is a great solid state drive, but PCIe form factor can limit its usability. In an effort to be a little more flexible, Intel has also released a U.2 version of the drive.

This uses the traditional 2.5-inch SSD form, though very thick at 15mm and weighing in at 125 grams. A big part of this is a chunky metal heatsink to help keep the SSD cool, which along with the size, rules out potential laptop use.

The U.2 version of the Intel 750 series still uses PCIe x4 and NVMe, just over a special cable. While not super common, U.2 connectors are available on high-end motherboards. It is also possible to get an adaptor that allows it to be plugged into an M.2 port. In other words, U.2 is like M.2 on a cable, which can give extra mounting flexibility, and makes cooling the drive easier. It does need external power, though, using a standard SATA style power connector.

The U.2 Intel 750 series should, in theory, offer the same performance as the PCIe slot version, but in practice, it is slightly slower. We tested the 400GB model, so the speeds are not directly comparable to the 1.2TB PCIe version anyway.

The other problem with the drive is that, for now, it's hard to find and, even when you can find it, it's quite expensive. The dollar per GB ratio is not very competitive, but for those with unique builds, the flexibility of the U.2 connection is quite handy.

Verdict

A handy variation to the 750 series, but it comes at a significant cost.

$1200 | WWW.INTEL.COM

Capacity: 400GB, 800GB, 1.2TB; **Controller:** Intel CH29AE41AB0; **Interface:** PCIe x4; **Size:** Half Height PCIe; **Endurance:** 70GB per day; **Warranty:** 5 years

Intel 750 Series PCIe

Unbeatable speed.

Originally launched mid last year, the Intel 750 continues to dominate when it comes to raw performance. The drive is also now significantly cheaper and is available in an 800GB model, as well as a 400GB and 1.2TB versions. Unlike the M.2 drives also tested, the 750 series is PCIe only, consisting of a half-height card with a meaty heatsink.

To ensure the fastest speeds, the SSD uses x4 Gen 3.0 lanes, as well as NVMe rather than AHCI. The actual storage is Intel 20nm MLC NAND, coupled up to 4GB of cache RAM and served by an Intel CH29AE41AB0 controller. The whole shebang is covered by a five-year warranty, and rated at 70GB of data written per day.

The Intel 750 series easily topped our benchmarks – but keep in mind we tested the 1.2TB model, and the smaller versions will be a little slower. Interestingly, Intel actually rates the 800GB model as the slowest of the three, though it's not enough for most users to notice in day-to-day use.

The 750 manages some pretty impressive read and write speeds – hitting 2,211MB/s read and 1,274MB/s write. 4K speeds are great, too (at 36MB/s and 210MB/s).

Importantly, the Intel 750 is also available at a fairly compelling price. As expected, the 1.2TB model is the best value, and if you shop around, it can be found for as little as $1 a GB. The smaller capacity models give slightly worse 'bang for buck' ratios, but are still decent value.

Verdict

Top notch performance for as little as $1 a GB.

★★★★½

$400 | WWW.KINGSTON.COM

Capacity: 240 GB, 480 GB; **Controller:** Marvell 88SS9293; **Interface:** PCIe 2x; **Size:** Half height PCIe; **Endurance:** 800GB per day; **Warranty:** 3 years

Kingston HyperX Predator

For those that need a flexible option.

The Kingston HyperX predator is a M.2 SSD at heart, but is also sold with a half-height, half-length PCIe adaptor card for wider compatibility. The drive is available in either 240GB or 480GB capacities, using the 2280 form factor.

The Kingston SSD uses a PCIe x2, Gen 2.0 interface, and AHCI, not NVMe. The drive sports Toshiba A19 NAND, 1GB of cache RAM, and a second gen Marvell 88SS9293 controller. The result is an extremely fast SSD, which easily bests those still using the SATA interface.

In our testing, the HyperX Predator hit 1,206MB/s and 902MB/s sequential read and write speeds, respectively. It also managed excellent 33MB/s and 104MB/s 4K random read and write speeds. We tested the 480GB model, and while the smaller 240GB offers the same read speeds, write speeds are about 40% slower.

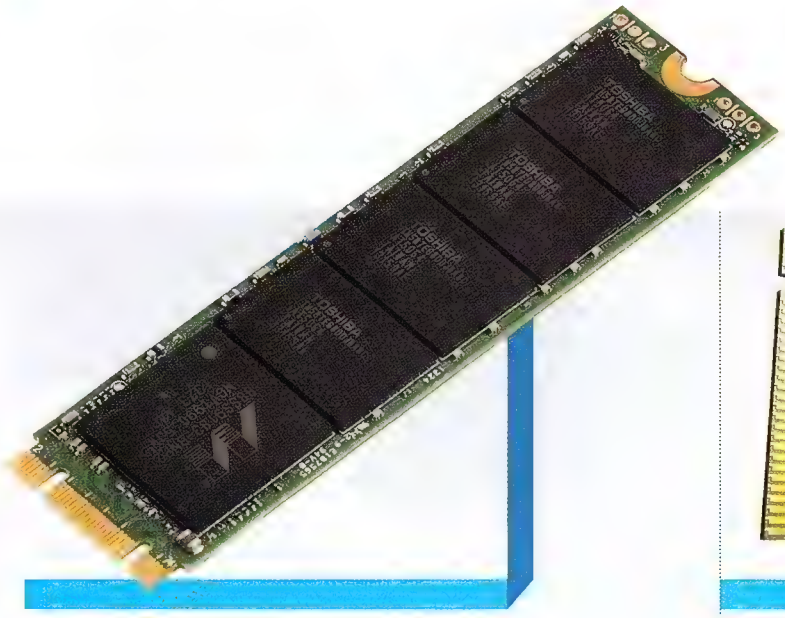
The Predator comes with a three-year warranty, and is rated for 882TB (480GB) and 415TB (240GB) total bytes written. To manage that in the three-year warranty, you would need to write about 1.6 times the capacity of the drive every single day. The drive comes with downloadable HDD cloning software, which can help make it easier to transition across.

The Predator was actually launched last year, which means that prices have dropped significantly since. Both capacities offer the same excellent $ to GB ratio, where each GB costs around 83c. Some cards are sold without the PCIe adaptor, but the prices are not really any different, so make sure you shop around.

Verdict

Fast desktop or laptop performance without costing an arm or a leg.

★★★★½



$210 | WWW.GOPLEXTOR.COM

Capacity: 128GB, 256GB, 512 GB; **Controller:** Marvell 88SS9183; **Interface:** PCIe 2x; **Size:** M.2 2280; **Endurance:** Not given; **Warranty:** 5 years

Plextor M6e

Is it worth waiting for a newer revision of this aging model?

The Plextor M6e launched back in 2015, but hasn't since seen the sort of price drops other brands have experienced. The drive uses M.2, with a 2280 form factor, AHCI and x2 PCIe interface. It's available as a standard M.2 SSD, or with a half-height PCIe riser card. The M6e features Toshiba 19nm MLC NAND and a 256MB DDR3 RAM cache, all driven by a Marvell 88SS9183 controller.

While faster than SATA SSDs, the M6e is still a long way behind some of the competition. In our testing of the 128GB model, sequential reads hit 681MB/s. while writes were significantly slower at 324MB/s. The larger capacities actually offer higher write speeds, and will manage at least 500MB/s. 4K Random reads and writes are not too bad, at 24MB/s and 81MB/s, respectively.

The Plextor SSD is not a bad drive in itself, but just not price competitive. Even the 512GB model costs more than competing SSDs that offer a whole lot more performance. The smaller capacities are even worse, and the 128GB model tested offered the worst $ to GB ratio of any drive tested.

Instead, you are much better holding out for the new M8Pe, which was announced at Computex and will be available later on this year. The new drives use M.2, but ditch ACHI in favour of NVMe, using the new Marvell 88SS1093 controller. The drive will use a x4 PCIe interface for speeds up to 2,500MB/s, and ship in 128GB, 256GB, 512GB and 1TB capacities.

Verdict

Faster than SATA, but not worth the cost compared to the competition.

★★★☆☆

$230 | WWW.SAMSUNG.COM/AU

Capacity: 256GB, 512 GB; **Controller:** Marvell UBX; **Interface:** PCIe 4x; **Size:** M.2 2280, **Endurance:** 220GB per day; **Warranty:** 5 years

Samsung 950 Pro

Can any other SSD compete?

Launched late in 2015, the Samsung 950 Pro was ultra-fast, but commanded a high price. Now over half a year later, it's both one of the fastest and cheapest M.2 SSDs available. The 950 Pro uses NVMe, and PCIe Gen 3 x4, on the standard 2280 form factor. It features 512MB of cache RAM, and uses the Samsung UBX controller. It also uses Samsung's V-NAND – in this case, 32-layer 128Gbit MLC.

Not surprisingly, the Samsung SSD is crazy fast, and we managed an impressive 2,132MB/s sequential read, and 988MB/s write. We tested the 256GB model, which does offer s significantly reduced write speed – the 512GB 950 Pro should hit closer to 1,200MB/s write speeds. The 4K Random read and write speeds were also top notch at 52MB/s and 161MB/s, respectively.

Overall, the only drive that could consistently outperform the 950 is the Intel 750, and even then, the Samsung still got ahead at times. The 750 is also a PCIe-only SSD, so not really an apples to apples comparison.

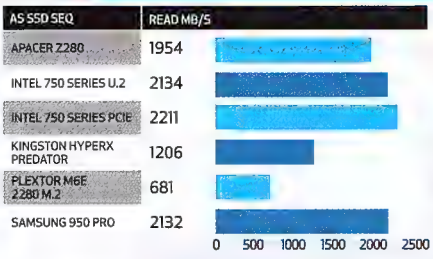
The 950 Pro supports AES-256-bit encryption, has a five-year warranty and a 400TB endurance (220GB per day). In terms of this testing, and GB per dollar, the 512GB Samsung 950 Pro ($400) has no equal. Sure, other SSDs are cheaper, but not for an ultra-fast NVMe M.2 drive. The 256GB model ($230) faces a bit of competition from Kingston, but once again, the Samsung gives better performance.

Verdict

The latest features and performance for a fantastic price.

★★★★½

LABS BENCHMARK RESULTS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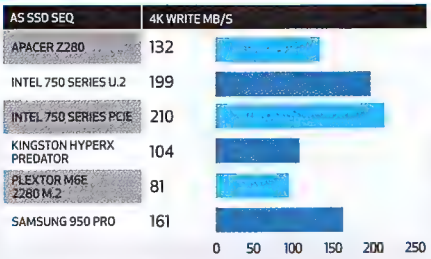
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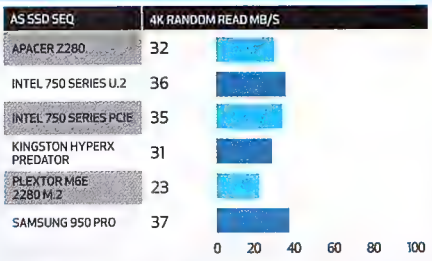
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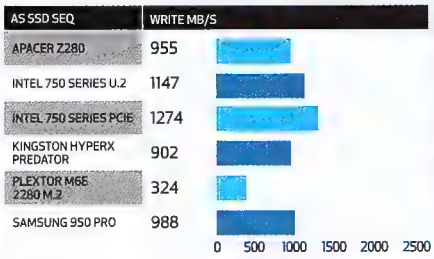
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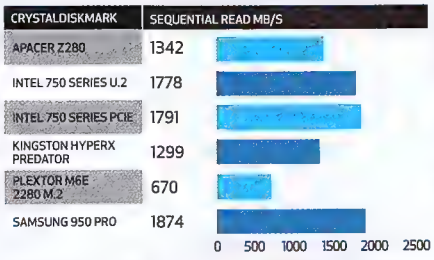
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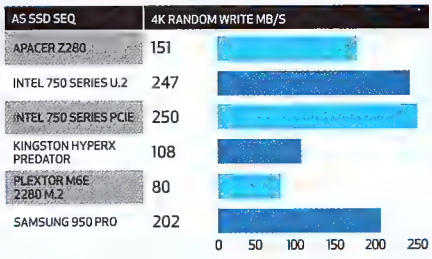
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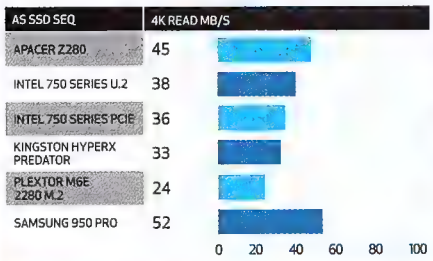
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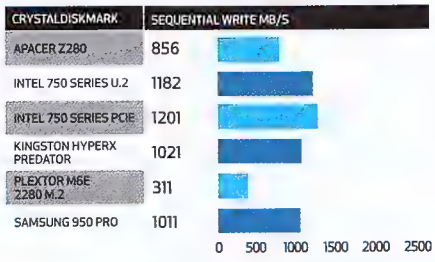
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KINGSTON HYPERX PREDATOR 1021
PLEXTOR M6E 2280 M.2 311
SAMSUNG 950 PRO 1011
0 500 1000 1500 2000 2500

SSDs: HOW THEY PERFORM

DRIVE	CAPACITY (GB)	PRICE ($)	$ PER GB (LOWER IS BETTER)	NVME / AHCI	INTERFACE	CONTROLLER	ENDURANCE GB PER DAY	WARRANTY
APACER Z280								
	240	TBC	TBC	NVME	M.2 PCIE X4	PHISON PS5007-11	NOT GIVEN	3 YEARS
	480	TBC	TBC	NVME	M.2 PCIE X4	PHISON PS5007-11	NOT GIVEN	3 YEARS
INTEL 750 SERIES U.2								
	400	629	1.57	NVME	PCIE X4	INTEL CH29AE-41AB0	70 GB	5 YEARS
	800	1150	1.44	NVME	PCIE X4	INTEL CH29AE-41AB0	70 GB	5 YEARS
	1200	1650	1.38	NVME	PCIE X4	INTEL CH29AE-41AB0	70 GB	5 YEARS
INTEL 750 SERIES PCIE								
	400	470	1.18	NVME	PCIE X4	INTEL CH29AE-41AB0	70 GB	5 YEARS
	800	850	1.06	NVME	PCIE X4	INTEL CH29AE-41AB0	70 GB	5 YEARS
	1200	1200	1.00	NVME	PCIE X4	INTEL CH29AE-41AB0	70 GB	5 YEARS
KINGSTON HYPERX PREDATOR								
	240	200	0.83	AHCI	M.2 PCIE X2	MARVELL 88SS9293	800 GB	3 YEARS
	480	400	0.83	AHCI	M.2 PCIE X2	MARVELL 88SS9293	800 GB	3 YEARS
PLEXTOR M6E 2280 M.2								
	128	210	1.64	AHCI	M.2 PCIE X2	MARVELL 88SS9183	NOT GIVEN	5 YEARS
	256	329	1.29	AHCI	M.2 PCIE X2	MARVELL 88SS9183	NOT GIVEN	5 YEARS
	512	568	1.11	AHCI	M.2 PCIE X2	MARVELL 88SS9183	NOT GIVEN	5 YEARS
SAMSUNG 950 PRO								
	256	230	0.90	NVME	M.2 PCIE X4	MARVELL UBX	220 GB	5 YEARS
	512	400	0.78	NVME	M.2 PCIE X4	MARVELL UBX	220 GB	5 YEARS

"When it comes to building your own rig, it's a vital tool for helping you improve your technique and knowledge for next time. Forethought and planning — that's what's key."

Build a killer X99 desktop PC

Zak Storey shows what happens when Intel and Nvidia join forces to power one gnarly 4K, VR and rendering machine.

THE CONCEPT

Whether it's 900bhp hypercars or the full, unbridled fury of an Atlas V rocket heading into low-Earth orbit, there's something about insane power that inescapably draws all human beings toward it. Breaking barriers is in our nature. It's what our species does best. Although it's rarely cost-effective or realistic, having access to the ludicrous is something the vast majority of us covet.

Without a doubt, then, we can safely say this machine has a hint of craziness about it. Let's be honest, you know why we pieced this machine together — to show off the incredible madness held within the depths of each of those wily sub-16-nanometre high-end processors.

So how do we justify a machine like this? Simple. As a 4K, VR-ready gaming workstation — that's our excuse for putting this monstrosity together. There's no fancy custom loop water cooling found here, no complicated setups, or anything along those lines. Just simple plug and play hardware, and a hell of a hit to the old wallet. But if you need it, you need it.

A RENDERING GIANT

How do you piece together a leviathan like this? Well, the CPU is always a good place to start. The Core i7-6950X is Intel's first deca-core processor, and coming in at a respectable $2,579 (ha, who are we kidding – it's insane!), it's the backbone of our PC. We coupled that with ASUS's updated X99-A II motherboard. Although not as high-end as its deluxe series, it still has all the features and expandability options we were after.

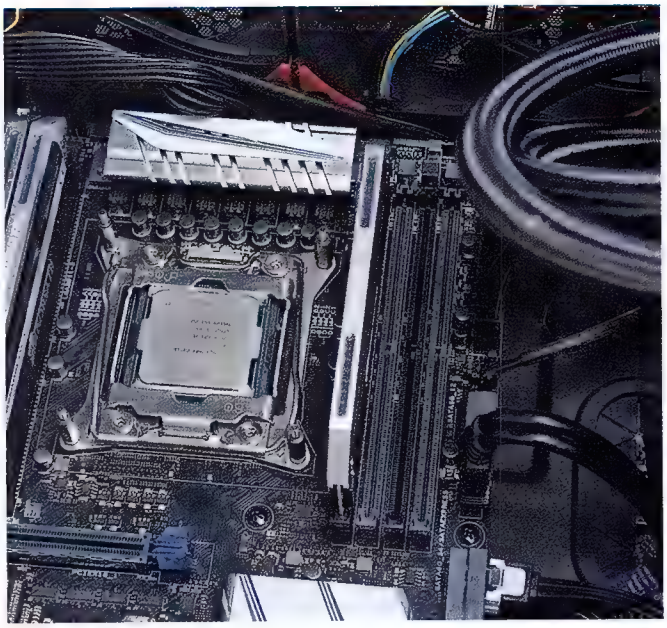
We had to couple that with 64GB of Corsair's finest, a fully digital 1,000W power supply in the form of the HX1000i, and a case: a Corsair Carbide 400C. This mid-tower chassis has ample room for dependable airflow, and its clean, straight lines ensure we'll be getting a build that looks as classy as its price tag. We did consider the 600C, but that inverse layout has caused enough controversy since its release. For storage, we opted for 12TB of Western Digital's Black drives, and a single 1.2TB PCIe NVMe Intel 750 SSD for the OS.

But wait! We can't forget about that pixel-rendering beauty sitting in the middle of this beast – the GTX 1080. The world's most powerful single GPU right now. Although a bit of a price hike in contrast to the GTX 980 – even if we were using the non-Founders Edition – it's still the biggest and best graphical kid on the block. Our only regret? We wished we had two for this build. Alas...

INGREDIENTS

PART		STREET PRICE
CASE	CORSAIR CARBIDE 400C	$149
MOTHER-BOARD	ASUS X99-AII	$499
CPU	INTEL CORE I7-6950X @ 4.3GHZ	$2,579
MEMORY	CORSAIR DOMINATOR PLATINUM 64GB (8X 8GB) 2,400MT/S	$729
GPU	NVIDIA GEFORCE GTX 1080 FOUNDERS EDITION	$1,199
PSU	CORSAIR HX1000I	$329
STORAGE 1	INTEL 750 SERIES 1.2TB PCIE NVME SSD	$1,349
STORAGE 2	2X WD BLACK 6TB 7,200RPM HDD	$858
COOLING	CORSAIR HYDRO H100I V2, 2X NOCTUA NF-F12 IPPC 120MM, 2X NOCTUA AF-F14 IPPC 140MM	$307
TOTAL		$7,998

"The Core i7-6950X is Intel's first deca-core processor, and coming in at a respectable $2,579 (ha, who are we kidding – it's insane!), it's the backbone of our PC."

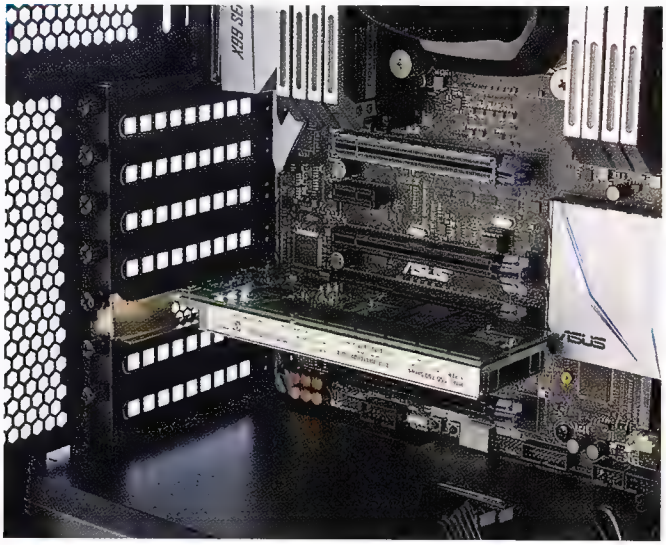


1 CASE WOES

The 400C is one of the cleanest cases out there, but there's a few things you should bear in mind. Firstly, the power supply cover. To install your PSU, you need to remove that little devil by undoing the three screws on the rear of the motherboard tray. You can then remove the panels and gain access to install the PSU. Unfortunately, there's no other way to install it. Next thing you'll want to do is slide the 3.5-inch hard drive bay across to the left – there are another two thumbscrews located just below the ones from the PSU cover for this. By doing this, you gain extra space to plug in your cables and keep everything nice and organised. One quick tip: Install the PSU and route the CPU power up to the top of the chassis prior to installing the motherboard. It'll save you a lot of effort in the long run.

2 MEMORY AND COOLER

For this build, we chose Corsair's Hydro H100i V2. We'll be honest, there's not a lot of difference — certainly from an installation standpoint — between different AIO coolers. In this chassis, we chose to install the radiator in the front of the case, ensuring we could pull cool air into the system. Install your radiator and fans before your motherboard; this way, you can route the fan cables where they need to be ahead of time, so there's no hassle later on, trying to install them around your hardware. It's also a smart move to install your memory first, before attaching the heatsink, so you avoid trying to manoeuver your DIMMs around the AIO's tubing runs. DDR4's notches are a little more subtle than the DDR3, so make sure you line up the notch on the bottom of the DIMM with the notch on the motherboard.



3 PCIE STORAGE

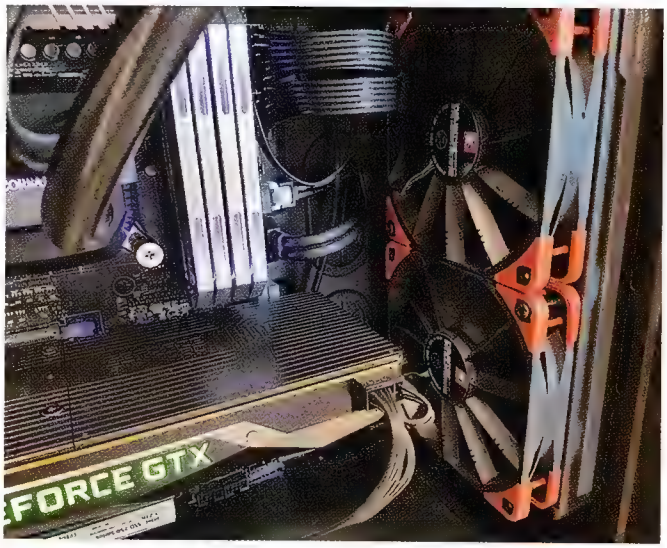
Intel's 750 Series PCIe SSDs bring large capacities and jaw-dropping read and write speeds to the masses. We took advantage of the 1.2TB variant, coming in at $1,349. If that's a little beyond your budget, you could easily opt for a smaller 400GB version instead, to house your OS and most-used programs. On top of that, if the PCIe card look isn't your jam, or if you fancy running GTX 1080s in SLI, Intel also sells a 2.5-inch variant that connects to the ASUS X99-A II via the U.2 standard. And if you really can't be fussed with that, you could opt for a Samsung 950 Pro instead — although it can throttle just a touch under load, this M.2 drive will sit snugly below your graphics card, making placement infinitely easier.

4 INSTALLING 3.5-INCH DRIVES

Installing the two mighty 6TB WD Blacks can be a little tricky, especially as the Corsair 400C is a fairly compact case. Make sure you run your SATA cables from your motherboard first, and ensure you've got a SATA power daisy chain running out of your PSU. Another pro tip is to avoid any of the angled SATA cables — your best bet is to use straight ones, especially if you're occupying both bays. These two Western Digital Black drives boast some insane capacities, ensuring you'll have plenty of redundancy for when the crap hits the fan. We chose to keep them stock, but setting up a RAID 1 or 10 array isn't a bad idea. On top of that, there are three additional 2.5-inch slots on the back of the motherboard tray, if you want to expand your SSD storage even further.

5 KING OF THE HILL

The GTX 1080 is the pinnacle of single GPU graphics technology at the moment — it kicks absolute arse — but in relative terms, not a lot has changed since the last generation, as far as installation goes. Plug it in, screw it down, make sure it's got enough breathing room, remember it's a blower-style card — it sucks air in for its coolant, as opposed to circulating it — plug in your power, and you're good to go. The biggest change for us lies in that single eight-pin power connector. Although you could, hypothetically, daisy-chain two GTX 1080s off a single cable, we advise against it, especially considering how power-hungry these babies are. Your best bet is to run two separate cables up to each of your GPUs here, especially if you want to overclock them. And, boy, do these things OC!



6 FILLING THE LOOP

We're a big fan (ha!) of Noctua here in the office — who isn't? — and, for this build, we opted to pump the air around with these little beauties. We chose to run two Noctua NF-F12 iPPC 2,000rpm 120mm fans for the front AIO cooler, pulling cool air through the radiator and into the chassis. And then we have two NF-A14 iPPC 2,000rpm 140mm fans drawing cold air directly in through the roof. There's a couple of reasons for this. Firstly, the horrendous number of cables littered across the top of the motherboard is a nightmare — having them potentially get caught in the fan blades is just going to suck. Secondly, a positive pressure system will make cleaning out your build a little easier in the long run, because all the air drawn into the chassis is filtered, and it's pushed out of all the unfiltered areas. We're all about that system maintenance.

1 If you really want to get the maximum cooling potential out of this little chassis, you can opt to install a 280mm AIO instead of the 240mm we used. However, it still needs to go in the front, because roof spacing is still just too tight.

2 In hindsight, to make this build tidier, we should have opted to run the single eight-pin PCIe power through the grommet to the right of the motherboard/GPU. Although it's absolutely fine coming out of the floor like that, it does look a little awkward and out of place.

3 The 400C in combo with this motherboard has plenty of space for an SLI setup. In fact, if you dropped the Intel 750 Series SSD down one slot, and installed a GTX 1080 in its place, you would have zero airflow problems, and one cool SLI powerhouse.

4 The only downside with the PSU cover in the 400C is that you can't extend it all the way across. We understand it's there to ensure sufficient radiator support for 360mm AIOs and radiators, but the option would have been nice to hide our HDDs completely, once slid across.

THERE ARE RENDERING STATIONS, THEN THERE'S THIS.

Hindsight is a wonderful thing. When it comes to building your own rig, it's a vital tool for helping you improve your technique and knowledge for next time. Forethought and planning – that's what's key. For this Build It project, it was all about cable management and studying how the chassis worked.

Take the X99-A II motherboard, for instance. It's a swell update on ASUS's last iteration, but there's one problem: the position of the CPU power. As it's direct centre, at the top, it makes it difficult to route your EPS eight-pin, especially in combination with the Corsair 400C, as it lacks a third rubber grommet in that central area. So you end up trailing CPU power from the top-left of the chassis, right across the bottom of your fans. This also manages to cut off access to the three CPU PWM fan headers in the process. It's an immensely tight squeeze to get that EPS power connected when you have two additional 140mm fans, as well.

Even for us, these are problems we couldn't predict. Adapting and overcoming those predicaments – in our eyes, at least – is what makes being a PC enthusiast and building your own system so gratifying.

So what do 10 cores, 20 threads, 64GB of DDR4, a 16nm FinFET GTX 1080 and over 13TB of storage gain you? One gnarly machine.

Overclocking the Core i7-6950X was a doddle. We dropped in the 2,400MT/s XMP settings, switched off SpeedStep, enabled full power phase control, and started upping the multiplier and voltage until we reached a stable point for thermals and system stability. We managed 4.3GHz with a cushy 1.285V on the CPU core. And this is where that deca-core monster shone, racking up an astonishing 2,208 points in Cinebench R15. To put that into perspective, a mainstream Core i7 6700K @ 4.9GHz only manages 1,074, and the last-gen i7-5960X eight-core processor can only hit 1,387 points at stock. Mind blowing.

Other than that, we saw an impressive 8,400 points in PC Mark 8's Creative benchmark, and 3D Mark's Fire Strike scored well over 18,000 points – that's a thousand points higher than just utilising an i7-6700K with the GTX 1080, which goes to show how much those additional cores benefit advanced physics simulation.

This machine is overkill, no doubt about it. It's $7,900-plus of grade-A red meat rammed into a sleek, clean chassis. The perfect 4K render workstation, that also excels at gaming. There's only a few things we'd change: a custom cable kit to make this build look incredibly clean, and perhaps another GTX 1080 Founders Edition, with one of those swanky new SLI bridges Nvidia has developed. That would have capped it off as one of the best consumer workstations in the world.

BENCHMARKS

	APC LABS TEST PC	THIS SYSTEM
CINEBENCH R15 MULTITHREAD	1,074	2,208 (106%)
CINEBENCH R15 SINGLE THREAD	213	176 (-17%)
TECHARP'S X264 HD 5.0.1 (FPS)	24.6	45.6 (85%)
PC MARK 8 CREATIVE	7,675	8,400 (9%)
RISE OF THE TOMB RAIDER	41	65 (59%)
FAR CRY PRIMAL	76	102 (34%)
THE DIVISION	78	105 (35%)

Our *APC* Labs Test PC uses a Core i7-6700K CPU @ 4.6GHz, an AMD R9 Fury X and 32GB of RAM. All games are tested at 1080p on max settings, with HD texture packages installed.

HoloLens
THE FUTURE OF EVERYTHING

Windows changed the world. Will HoloLens do the same?

Technology companies can sometimes get carried away when it comes to selling their latest and greatest products. "This new laptop will change your life!" "This smartphone is the greatest thing ever!" And so on... But they will occasionally actually come up with something so amazing, so incredibly mind-blowing, that there's no need to hype it.

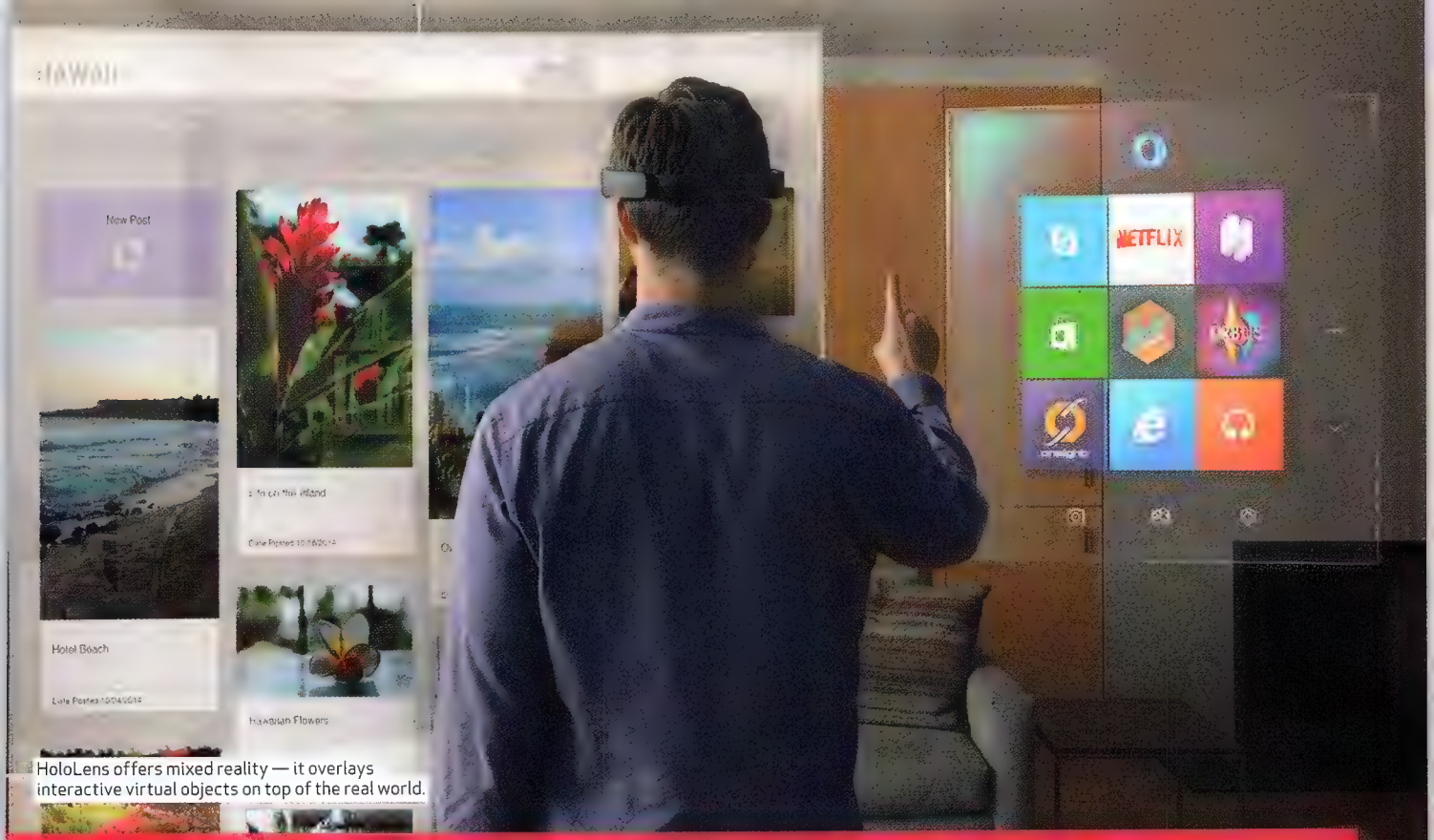
This is what Microsoft has done with the HoloLens, which might just be the future of everything.

HoloLens is truly an extraordinary gadget. It could change the way you communicate with friends and family all around the world. It could change the way you learn and teach others, too. It could transform the way you work. It could revolutionise the entertainment industry. It could replace your TV, your PC and your Xbox. It could fix your plumbing and cure your fear of spiders. And it could be the ultimate way to be close to the people you're missing when you're far from home. So just what is this amazing piece of equipment?

Over the next few pages, we'll explain why HoloLens is such a big deal, what the likes of Google, Facebook and Samsung want you to use instead, and most importantly of all, how you can get your hands on it.

We'll also take a look at how it compares to some other similar gadgets out there.

We haven't been this excited about a piece of new tech in a very long while. And when you've finished reading this, we think you will be, too. So here's to the future!



HoloLens offers mixed reality — it overlays interactive virtual objects on top of the real world.

PERSONAL COMPUTING

WHAT MIGHT THE IMPACT BE WHEN MIXED REALITY COMES TO THE HOME?

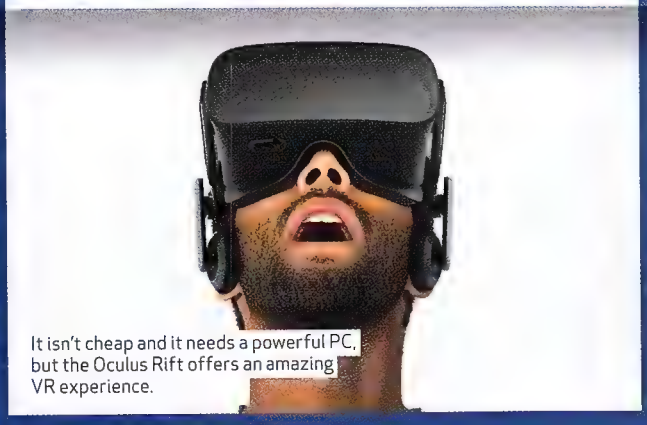
HoloLens is a mixed reality headset. You've no doubt heard about virtual reality (we've mentioned it often) and possibly augmented reality, too – the former is when you explore an entirely computer-generated world, and the latter is when you overlay computer-generated information on the real world.

Mixed reality, as the name suggests, mixes the two things. With HoloLens, you can see things that aren't there and also interact with them. Imagine receiving a video call from a relative and seeing them right in front of you. Imagine a game where space aliens are shooting at you from behind the sofa. Imagine having the ability to magic an unfeasibly gigantic TV on any wall and play *Halo 5* on it. Imagine looking in your driveway and seeing the car you're thinking of buying. Imagine your favourite apps hovering in the air around you.

That's what HoloLens does today. Imagine what it might do tomorrow.

> "Imagine looking in your driveway and seeing the car you're thinking of buying."

HoloLens versus... Oculus Rift


It isn't cheap and it needs a powerful PC, but the Oculus Rift offers an amazing VR experience.

Oculus kickstarted the current VR trend, and now that Facebook's snapped it up, it's the one most likely to do big things. It also requires big pockets. The consumer edition is US$649 (not including the ~US$130 postage to Australia) and you'll need a PC with an Intel Core i5-4590 or better, at least 8GB of RAM, three USB 3.0 ports and an Nvidia GTX 970 or AMD R9 290 graphics card. If your PC doesn't have that spec, plenty of US PC makers are spruiking Oculus-certified PCs, but they aren't cheap — so far, the cheapest is from Dell and costs US$999. We haven't seen any Aussie retailers being involved in the Oculus-certified program yet. You'll also need the Oculus Touch controllers for full immersion, but they're out yet and Oculus hasn't announced a final price either.

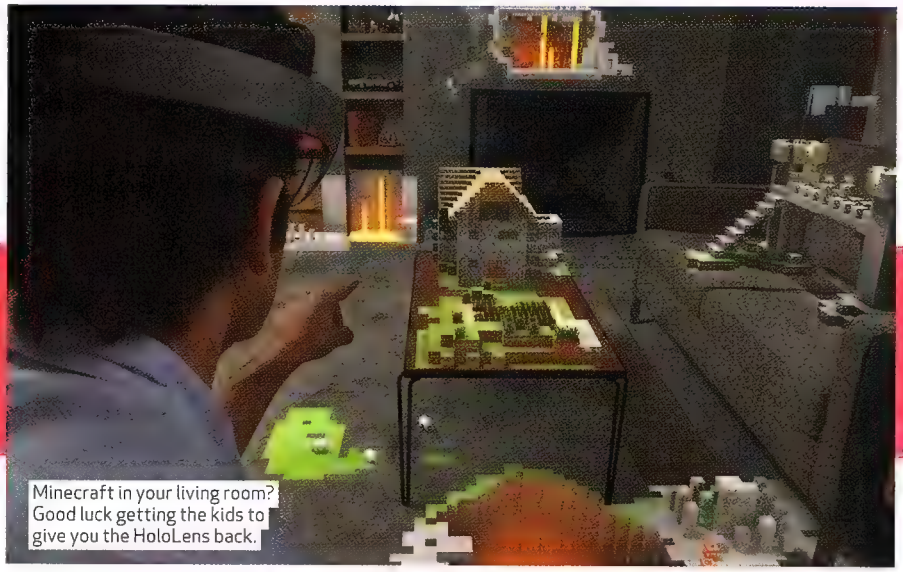
HoloLens versus... HTC Vive

HTC's Vive has been developed in conjunction with gaming giant Steam, but actual VR games are still few in number.

Gaming service Steam has teamed up with HTC to create the Vive, a US$899 (plus shipping) VR headset that's powered by a PC, and it has a particularly good feature called 'Lighthouse' — base stations that track where you are so you can interact without having to use controllers, although you'll need a decent-sized space to use them. It also has a front-facing camera so it can see what you're looking at, and which might enable HoloLens-like mixed reality in the future (it's off by default).

As with Oculus, the Vive wants a GTX 970 or R9 290 graphics card, but the rest of the PC needn't be as powerful as the one you need for the Oculus. HTC says an Intel Core i5-4590 or AMD FX 8350 should do the trick.

Steam VR is all about gaming and entertainment, but at the moment, dedicated VR titles are thin on the ground and that means the Vive is a risky bet until there are some games to play on it. It's interesting and fun, but it's not particularly worth rushing to the shops for.



Minecraft in your living room? Good luck getting the kids to give you the HoloLens back.

THE HOLO CROWN

HoloLens is what you get when you put a lightweight Windows PC into a headset that contains twin transparent video-screens and lots of sensors. It can see the world around you, it can see your gestures and feel your movements and hear your voice, and it can display things before your very eyes. Microsoft calls it 'holographic computing'. The things you see aren't real, but they look real and they respond to what you do.

HoloLens doesn't need to be connected to a games console or a PC — it is a PC, and because it's a Windows PC, it uses the same language as Windows 10 devices.

Oh, and it's US$3,000. But the HoloLens you and we could buy won't cost that much. The US$3,000 HoloLens is for app developers in the US and Canada, and it's a kit they can use to prepare the apps that might just change the world. That's out now, but the rest of us will have to wait until at least 2020, which is when Microsoft expects the consumer version of HoloLens to go on sale.

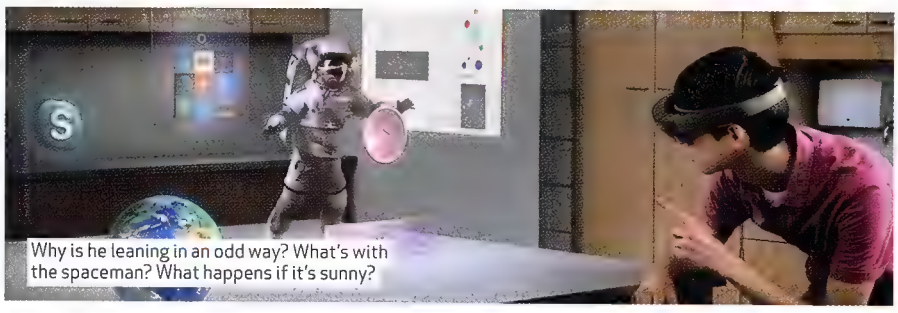
That's a good thing, because the version of HoloLens available right now isn't perfect. The battery's only good for five and a half hours. The field of view — the bit where your apps and virtual items appear — is a bit limited. And there aren't many apps yet.

FROM THE OTHER SIDE

One of the most exciting HoloLens apps could be communication. Fancy Skyping someone and seeing them appear in the room in front of you? HoloLens could do that, although the current model requires a separate camera for the other people to see you. It isn't just Microsoft that's thinking about this — Facebook paid big money for VR firm Oculus because it thinks the future of social networking might just be virtual.

If you've been online for a few years, you might be thinking you've heard this all before, and you're right — virtual social networks were the subject of a lot of hype several years ago, with big brands jumping into the virtual world of Second Life to try and sell us stuff. But while Second Life didn't live up to the hype, that doesn't mean virtual social networking isn't a big deal.

HoloLens isn't the only virtual/augmented/mixed reality device around, but it's one of the most ambitious. Where other devices are designed primarily for home entertainment or for corporate use, HoloLens wants to be like the PC — useful for every kind of application in any environment for any purpose. How's that for ambitious?



Why is he leaning in an odd way? What's with the spaceman? What happens if it's sunny?

HoloLens and computer-aided design (CAD) enable designers to see and change virtual objects.

LIFE-CHANGING TECH

HOW HOLOLENS COULD JUMP-START JOBS AND FIGHT OFF PHOBIAS.

The most successful treatment for phobias and post traumatic stress disorder is exposure, which means helping you lose your fear by exposing you to the thing you're frightened of.

Mixed reality enables that exposure to occur in a controlled environment where you're perfectly safe and the thing you're helplessly and irrationally afraid of isn't actually there. It's no wonder the medical community is interested in mixed, augmented and virtual realities as tools for treatment. A device such as HoloLens could be just as useful in a surgical capacity, too. Imagine the surgeon having access not just to what they can see, but anything he or she might possibly need to know, such as vital statistics, scans and X-rays, even how-to advice from more experienced doctors.

THE HOLO PEOPLE

Of all the uses of mixed reality, helping people at work is likely to be the killer app. Boeing engineers already use it to help make aeroplanes, with blueprints appearing in front of the physical objects they're working on. Imagine that for any kind of work where you could benefit from video how-tos, instant information or essential diagrams. Mechanics could see exactly how to do a task with graphics showing them what goes where. Tradespeople could see architecture plans, the insides of buildings and anything else they need to know. Virtual plumbers

HoloLens versus... Galaxy Gear VR

Samsung's Galaxy Gear VR is only $159, but it won't work without a recent Galaxy phone. They cost a bit more than that.

At $159, Samsung's Galaxy Gear VR is the most affordable VR headset around, but you need to have a recent Galaxy phone. It's really just a virtual reality viewer for apps whose processing is handled by the phone, and as a result, it can't come close to the quality, smoothness or power of more expensive rivals.

It's pitched squarely at the home entertainment market and it's really good fun, but the difference between Samsung's cheap and cheerful headset and more expensive VR systems is rather like the difference between a cheap handheld game and a triple-A title on an Xbox One. In other words, while they're both games, they each offer very different experiences.

As with any VR platform, the available apps range from brilliant to awful, but the main problem with the Samsung Gear VR is that it doesn't work with anyone else's hardware — so it's only really useful to Samsung Galaxy owners or to people willing to drop cash on a second-hand Samsung phone. At $159, it's a bargain, but at $159 plus the cost of the phone necessary to use it, it isn't a very wise investment unless you were planning to change phones anyway.

Volvo is experimenting with HoloLens to sell cars — and to build them, too.

could help you fix your leaking tap by pointing at the right bits as if they were right beside you, no doubt for an astronomical fee.

HoloLens can do much more. Product designers don't need to fire up their CNC machines or 3D printers to see exactly what their item will look like in the real world. Car salesmen could let you see the exact configuration of the car you're thinking of buying. Detectives could get a Batman-style ability to highlight important parts of a crime scene, or to see what it looked like before the clean-up crew arrived. Students could see the insides of human bodies without having to cut anybody open. And as NASA is currently demonstrating, normal people can see the surface of Mars without having to travel there.

More? Theme parks could add virtual characters to their real-world exhibits — you won't feel silly wearing HoloLens at Alton Towers if everybody else is, too — or turn any room into a haunted house. Paint firms could offer HoloLens apps that enable you to try out different colour schemes at home without using a single tester pot. Musicians could play gigs in every fan's front room. All of these are the tip of a potentially very exciting iceberg.

> "And, as NASA is currently demonstrating, normal people can see the surface of Mars without having to travel there."

HIT OR HYPE?

We don't think Microsoft is overhyping HoloLens. HoloLens is in the hands of app developers right now, but it'll be another four years before you or we can buy it. That's because Microsoft knows that, for HoloLens to live up to its grand promise, it needs to be genuinely useful — and that means apps, and plenty of them.

The five-year gap between the developer version and the consumer version also means the technology inside HoloLens can improve. If you look back at the best smartphones of five years ago, they had dual-core processors, 8 megapixel cameras and sub-HD screen resolutions. Now they're packing 20MP cameras, octa-core processors and 4K displays for the same money. Their connections are faster, their processors more energy efficient and their cases slimmer – so HoloLens will get smarter, lighter and do more with less by the time we can buy it. And it should be a lot less than several thousand dollars too.

HoloLens is hugely exciting, but it isn't alone here — in mixed reality, it has rivals including Meta and the secretive but very rich Magic Leap, and then there are the virtual reality headsets targeted at our living rooms.

However, it has allies, too — ASUS has announced plans for a HoloLens headset and we're sure Microsoft will encourage other OEMs to do the same.

With the Windows PC, Microsoft changed the world. With HoloLens, it might just do it again. We can't wait to see what's around the corner!

HoloLens versus... Google Cardboard

Cardboard is cheap, cheerful and fun, but cardboard isn't the most comfortable thing to have on your face.

When Google Cardboard was first announced, many people thought it was a joke, but it wasn't. In fact, it's the cheapest way to get VR, largely because it's just a bit of cardboard. It's a clever bit of cardboard, though, because it holds your phone in just the right place to experience VR apps. Google is on the second iteration of Cardboard now, so it supports phones with screens up to six inches, and firms such as Mattel offer plastic Cardboard viewers for around $40, if you don't fancy something as flimsy. It isn't as immersive as a 'proper' VR headset but it's the cheapest, easiest and most amusing way to dip your toe into virtual waters.

There's a good selection of VR apps and content too. You can watch VR clips from YouTube, download an app that takes your photos and turns them into VR spaces or just see far-flung locations. Riding a virtual rollercoaster from the safety of your sofa is a lot of fun, but if you're committing to Cardboard, you should invest in some foam padding as the rough edges can get uncomfortable.

how to

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

HARDWARE

'BIP BIP BIP SQUEEEEEEEE'

My PC is straight up broke. When I turn it on, it just gives one continuous tone that never stops. The screen stays black. I've done all the usual turn-it-on-and-off-again, try-starting-in-Safe-Mode stuff you normally recommend, but nothing. Bin it?
Anthony Bellagarde

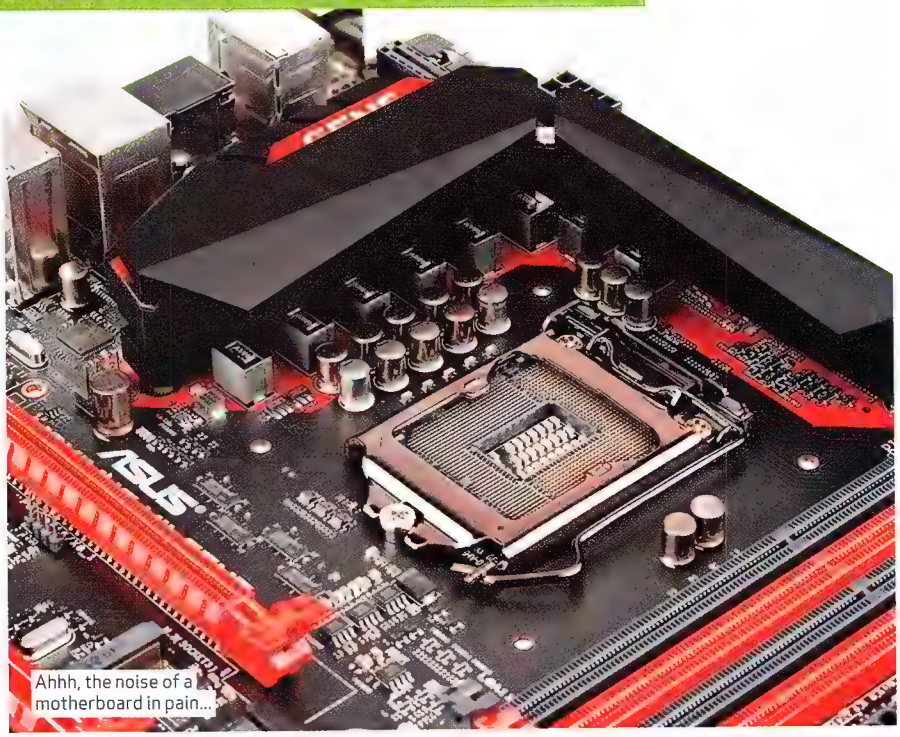
Not necessarily. Your PC may actually be so broke that it wraps all the way round again. All the standard diagnostic noises that the BIOS makes during the power-on self-test are combinations of beeps. There are error codes that will cause the motherboard to beep endlessly, but none that just give a continuous tone. So this is something even more fundamental than that. In the worst case scenario, it's a short on the motherboard (virtually impossible to locate and fix); in the best case it's a faulty power supply (around $90 to replace).

Since there's no way to tell without trying, and since a spare power supply is a handy thing to have lying around for future diagnostic shenanigans, I say you should buy a cheap 600W PSU and try swapping it. But yes, if that doesn't help, you can bin the PC.
Luis Villazon

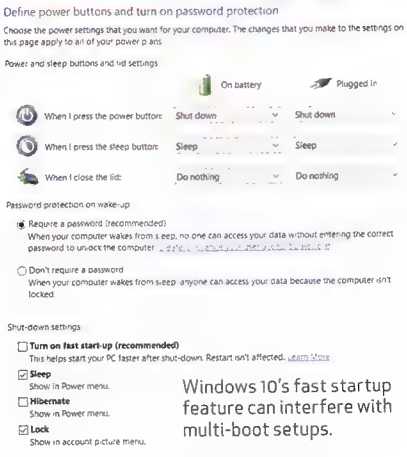
WINDOWS

BOOTING MULTIPLE OSS ALONGSIDE WINDOWS 10

I have a PC with two 500GB internal hard drives connected at all time — one with Windows XP (32-bit) and one with Windows 7 (64-bit). I have this setup because a couple of my old programs will not operate under Windows 7 64-bit. I recently added a third drive with Windows 10 looking to test it out. However, I've now hit problems booting XP and 7; unless I physically disconnect the data cables from the latter's disks, Windows 10 corrupts them somehow and the next time I try to load XP or 7, a message comes up saying that the disk has errors and needs to run CHKDSK. The only way I can run this system without errors is to make sure that I have disconnected the data cables from the other two drives. I have lost so much information from having to run CHKDSK that I have now totally removed the



Ahhh, the noise of a motherboard in pain...

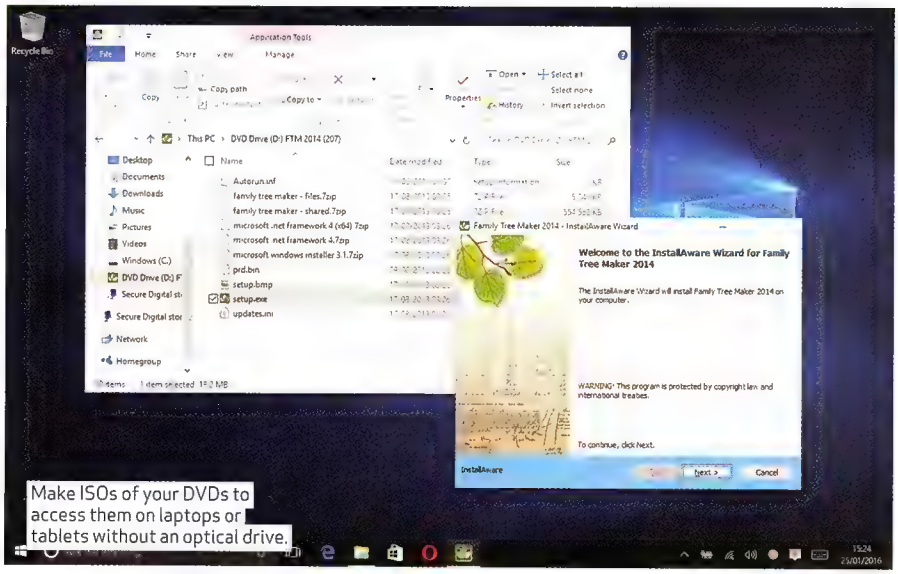

Define power buttons and turn on password protection
Choose the power settings that you want for your computer. The changes that you make to the settings on this page apply to all of your power plans.
Power and sleep buttons and lid settings
On battery
Plugged in
When I press the power button:
Shut down
Shut down
When I press the sleep button:
Sleep
Sleep
When I close the lid:
Do nothing
Do nothing
Password protection on wake-up
Require a password (recommended)
When your computer wakes from sleep, no one can access your data without entering the correct password to unlock the computer
Don't require a password
When your computer wakes from sleep, anyone can access your data because the computer isn't locked.
Shut-down settings
Turn on fast start-up (recommended)
This helps start your PC faster after shut-down. Restart isn't affected. Learn More
Sleep
Show in Power menu.
Hibernate
Show in Power menu.
Lock
Show in account picture menu.
Windows 10's fast startup feature can interfere with multi-boot setups.

Windows 10 drive from the box. Do you know what could be causing the above problem?
Ron Ronlund

This is likely a side-effect caused by Windows 10's 'fast startup' feature, which is usually enabled by default. It works a bit like hibernation did in previous version of Windows, in that it doesn't perform a regular shutdown when you power off the system. All users are logged off and programs closed, effectively returning Windows 10 to a 'freshly booted-up state', and this is then saved as a hibernation file on your OS drive. When you next boot up, Windows loads this hibernation file instead of booting and loading up everything again from scratch.

The problem for those dual-booting is that the above shutdown process presumes you're going to reboot back into Windows 10. During a normal OS shutdown, hard drives will have their caches flushed and are marked as having properly powered down — things which don't occur with fast startup enabled. So what's happening with Ron's system is that, on booting up Windows XP or 7 after a 'fast shutdown', they're both going, "Hey, this drive wasn't shut down properly, so I'd better thoroughly check it for errors!"

You can disable fast startup by going into Control Panel and making sure the 'View by' option is set to icons, then click 'Power Options' and 'Choose what the power buttons do'. Next, click 'Change settings that are currently unavailable' and finally uncheck the box next to 'Turn on fast startup (recommended)' should solve the issue



— at the price of a slower boot time for Windows 10, of course.

If you don't see the checkbox option, close the Power Options window, press Windows-X and then run 'Command Prompt (Admin)'. Type `powercfg /hibernate on` and hit Enter, then walk through the above steps again to disable fast startup.

Dan Gardiner

HARDWARE

ACCESSING DVDS ON A HYBRID LAPTOP?

I need to install a program from disc on my laptop, which has no disc drive. How do I do this?

Claire Hunt

You could pay around $40 for an external slimline DVD drive such as the Samsung SE-208GB, but a simpler option is to convert the DVD to an ISO file on another PC using the free Infrarecorder tool, then transfer that to your laptop. Then follow these steps:

1. Download and install the latest version of Infrarecorder from **www.infrarecorder.org** — once done, pop your target disc into the DVD drive and close any autoplay dialogue that appears. Launch InfraRecorder from the Start menu and click 'Read Disc'.

2. Verify your drive is selected under Source, then click '...' next to 'Image file' to select a location and give your ISO file a suitably descriptive name. Once done, click 'Save' followed by 'OK', then wait while the ISO file is created.

3. Once complete, you'll need to copy your ISO file to your laptop — use a shared folder on your local network or transfer the file using a device such as a USB flash drive. Copy it to a suitable folder on your laptop for easy access.

4. Once transferred to your laptop, simply double-click the ISO file — it'll automatically be mounted as a virtual disc and will open to show the disc's contents — simply double-click the setup file to install it to your laptop.

Cat Ellis

WINDOWS

ANNOYING WINDOWS BACKUP ERROR

I get an '0x807800c5' error when my Dell XPS desktop uses Windows Backup, which came with Windows 10 pre-installed. From what I can gather on the Microsoft support forum, there is no definitive answer — Dell's own factory Backup software works fine on a daily schedule, but I feel it would be good to have the Windows software working.

Mick Saunders

We checked with Mick for the actual error message that accompanied the code — it occurred on any drive he attempted to select for backup and claimed the mounted backup volume was inaccessible. We then discovered that Dell's Backup and Recovery tool isn't normally installed on new Windows 10 PCs, but should be compatible on older, upgraded PCs with an update (which was installed on Mick's PC). It's possible the Dell tool is conflicting with Windows Backup, in which case, removing it might possibly help, but we were able to verify that Mick can successfully run Windows 10's other backup tool, File History. We suggested that he pair this with Macrium Reflect Free (**www.macrium.com/reflectfree.aspx**) going forward and he was pleased to report both are working fine.

Graham Barlow

EXCEL

SERIAL NUMBER KILLER

I'm driving myself crazy trying to get Excel to behave the way I want. I am building a database of long (20-digit) serial numbers, but whenever I enter them, Excel converts them to 'scientific notation', like 1.2345E+019. If I force the format of the column to treat the data as numbers, it replaces the last few digits with zeroes!

Dean Menton

To create full system image backups in Windows, we recommend grabbing the free verison of Macrium Reflect.

By default, Excel, or any spreadsheet, attempts to guess the correct format based on the data you enter in the cell. So if you enter just digits, it will treat the result as a number, and if the number is too large to fit in the cell, it will display it using scientific notation. This notation is actually what Excel uses internally to represent numbers with lots of significant digits, and this explains the second problem. Excel can only handle a maximum of 16 significant digits — anything after that is truncated. Some spreadsheets, such as Libre Office, will round the last digit

correctly, but Excel seems to simply truncate them.

Serial numbers aren't really numbers; they're just unique identifiers. Plenty of so-called serial numbers contains letters as well and that's just fine because there aren't any situations where you need to multiply two serial numbers together or take the square root of a serial number. So, just format the cells as text before you enter the data. Text cells can hold a lot more characters and won't truncate. You can still sort the rows into ascending order of serial numbers if you need to.

If for some mad reason you need the serial numbers to be treated as actual numbers, you'll need to split each one into two columns. Enter the number as text initially, then in the next two columns take LEFT(A1,10) and RIGHT(A1,10). This preserves all the significant digits and whenever you need to perform a mathematical operation on the whole serial number, you can multiply the number in column B by 10 billion and add column C to the result. But bear in mind that you'll be subject to the same limits on significant digits as soon as you do this.

Luis Villazon

HARDWARE
RECYCLING PHONES

I'm very interested in the Raspberry Pi and Arduino, but it seems that, by the time you've invested in the board, a power supply, screen and some kind of data input hardware, you've already spent quite a bit. I have a kitchen drawer full of old phones, each of which has its own screen, faster processor and a lot more RAM than a Pi. What's to stop me taking one of these to bits and interfacing to that?

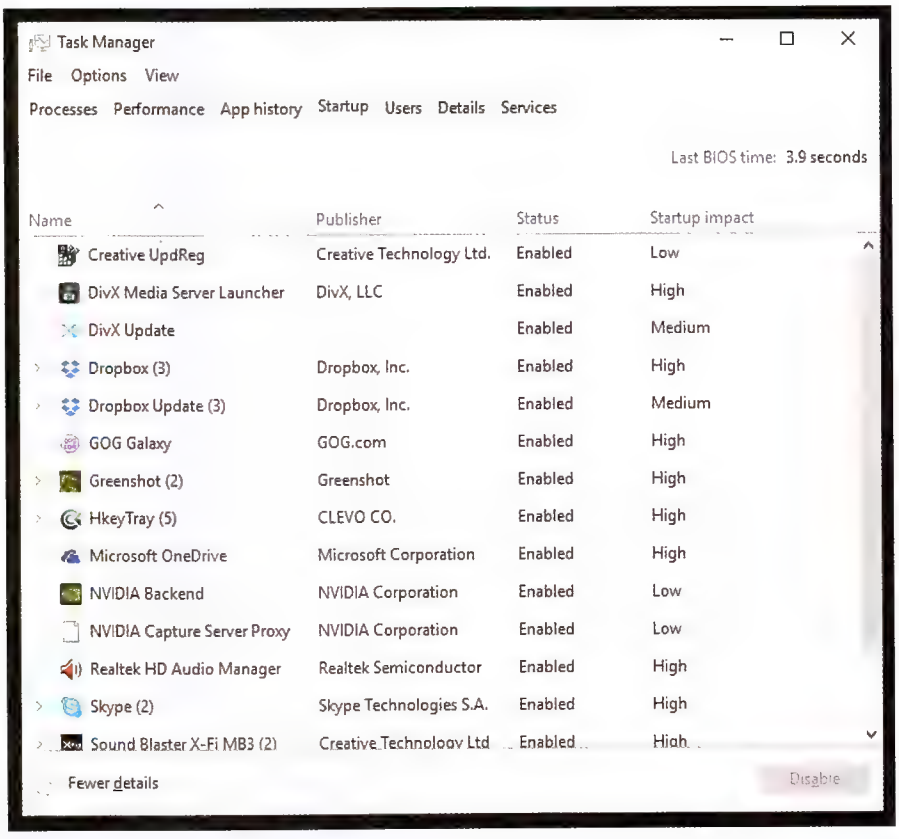
Peter French

Phones aren't easy to re-use in the way you're suggesting for a few different reasons; they use a custom circuit board with surface mounted, have machine-soldered components that will be difficult to remove, there's no general purpose I/O pins, and documentation is very limited. It's like the difference between buying, say, a Lego Bionicle versus dismantling a Buzz Lightyear toy so that you can reassemble it into something else.

Arduino and Raspberry Pi aren't really designed to be powerful – they're designed to be simple. Both are a lot cheaper than buying a phone just to cannibalise it for parts, and a lot simpler than interfacing with a phone even if you have one lying around for free. Home development kits built around phone architectures do exist – the ODROID, for example. But they aren't any cheaper.

Luis Villazon

Repurposing a smartphone's innards isn't as simple as you might hope.


Task Manager
File Options View
Processes Performance App history Startup Users Details Services
Last BIOS time: 3.9 seconds
Name Publisher Status Startup impact
Creative UpdReg Creative Technology Ltd. Enabled Low
DivX Media Server Launcher DivX, LLC Enabled High
DivX Update Enabled Medium
Dropbox (3) Dropbox, Inc. Enabled High
Dropbox Update (3) Dropbox, Inc. Enabled Medium
GOG Galaxy GOG.com Enabled High
Greenshot (2) Greenshot Enabled High
HkeyTray (5) CLEVO CO. Enabled High
Microsoft OneDrive Microsoft Corporation Enabled High
NVIDIA Backend NVIDIA Corporation Enabled Low
NVIDIA Capture Server Proxy NVIDIA Corporation Enabled Low
Realtek HD Audio Manager Realtek Semiconductor Enabled High
Skype (2) Skype Technologies S.A. Enabled High
Sound Blaster X-Fi MB3 (2) Creative Technology Ltd Enabled High
Fewer details
Disable

Windows 8 and 10's hybrid shutdown feature can sometimes mess with Startup apps.

WINDOWS
I HAVE TO START WINDOWS TWICE!

I think I've stumbled upon the weirdest thing ever! None of the programs in my Start-up group actually run when I start Windows. But if I disable them, restart Windows, re-enable them and then restart again, they will all load normally... until the next time I restart Windows. What the heck is going on? Why is Microsoft making me jump through these hoops?

Steve Proudhorn

This isn't even the weirdest thing this week. (That trophy goes to the seagull that flew over my house with a 3m length of washing line in its beak and somehow managed to get tangled up in my TV aerial.) The apps in the Start-up section of Task Manager are usually driver configuration utilities and low-level monitors. Most of them need to run with administrator privileges, which they inherit through your own user account privileges when you log in.

But if you have hybrid shutdown enabled (and you likely do, because it's the default in both Windows 8 and 10), then these apps can fail to elevate their running privileges correctly. Hybrid shutdown closes your user session normally, but saves the current state of the kernel session to disc. This makes it quicker to shut down, but when you start Windows the next time, the fresh user session and the old kernel session woken from hibernation can end up out of sync. Restarting Windows fixes the problem because hybrid shutdown isn't triggered on a restart, so the kernel session starts afresh that time.

Luis Villazon

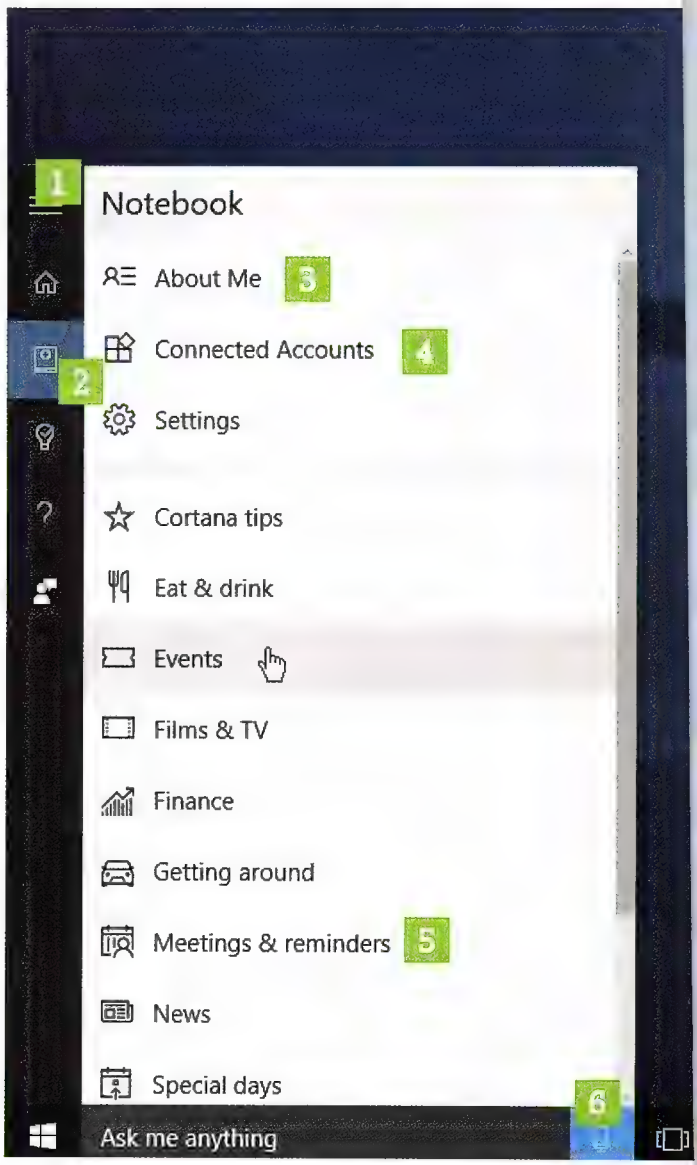
Personalise Windows 10's Cortana

Cat Ellis shows how Cortana, your new virtual assistant, can help you get the most out of Windows 10.

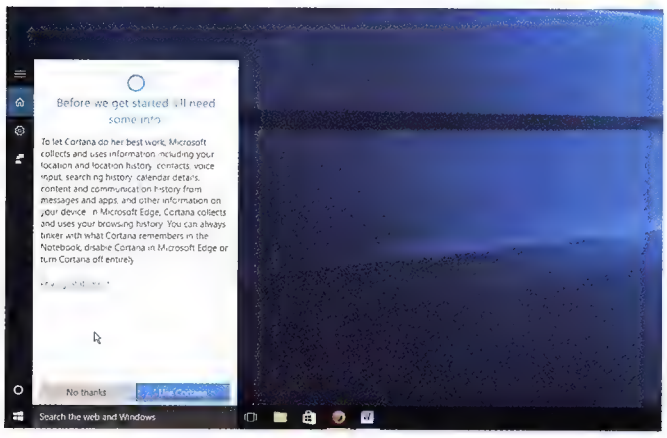
First introduced on handsets running Windows Phone, Microsoft's virtual personal assistant, Cortana, arrived on the desktop with the launch of Windows 10. Named after an artificial intelligence from science-fiction game series *Halo*, Cortana is much more than just a search tool – it (or she) also manages your calendar, tracks packages and even tells jokes.

Cortana packs in more features than Apple's assistant Siri, or Google Now, and you can make her even more personal by customising your settings to reflect your interests, activities and preferences. She works together with Microsoft's wealth of programs and tools to help you get even more from your PC. Let's get started!

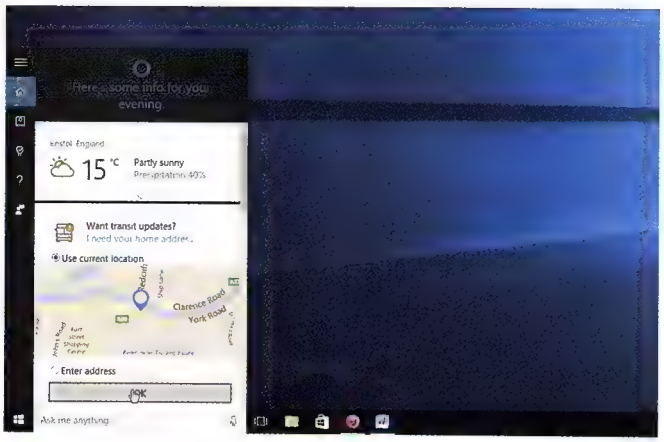
"Cortana packs in more features than Apple's assistant Siri or Google Now"



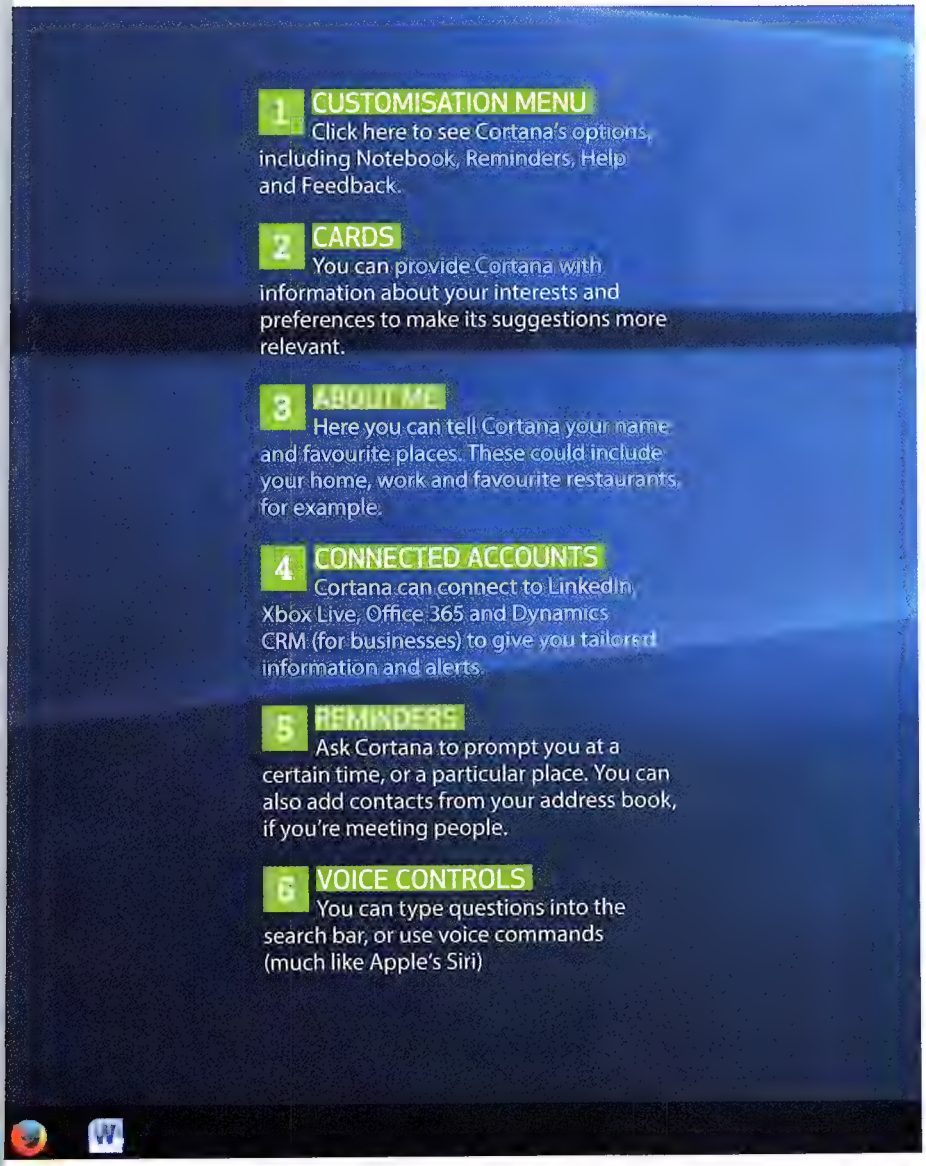
Train Cortana to suit your needs



1 MEET CORTANA
Cortana is accessed by clicking the Search box beside Windows 10's Start button. If an introduction to Cortana doesn't appear, click the circle icon on the left-hand side of the menu. Click 'Next', then click 'Use Cortana' to continue. You can now control Cortana by typing into the search box, or clicking the microphone icon and speaking — more on that later.



2 WHERE ARE YOU?
Cortana will automatically pick up your location and display it on a map, along with a weather report. If you're not currently at home, you can enter your address and Cortana will provide information like traffic reports so you know what to expect on the roads. It will also synchronise with your Google or Outlook calendar and provide reminders about forthcoming events.



1 CUSTOMISATION MENU
Click here to see Cortana's options, including Notebook, Reminders, Help and Feedback.

2 CARDS
You can provide Cortana with information about your interests and preferences to make its suggestions more relevant.

3 ABOUT ME
Here you can tell Cortana your name and favourite places. These could include your home, work and favourite restaurants, for example.

4 CONNECTED ACCOUNTS
Cortana can connect to LinkedIn, Xbox Live, Office 365 and Dynamics CRM (for businesses) to give you tailored information and alerts.

5 REMINDERS
Ask Cortana to prompt you at a certain time, or a particular place. You can also add contacts from your address book, if you're meeting people.

6 VOICE CONTROLS
You can type questions into the search bar, or use voice commands (much like Apple's Siri)

Cat's best tip!

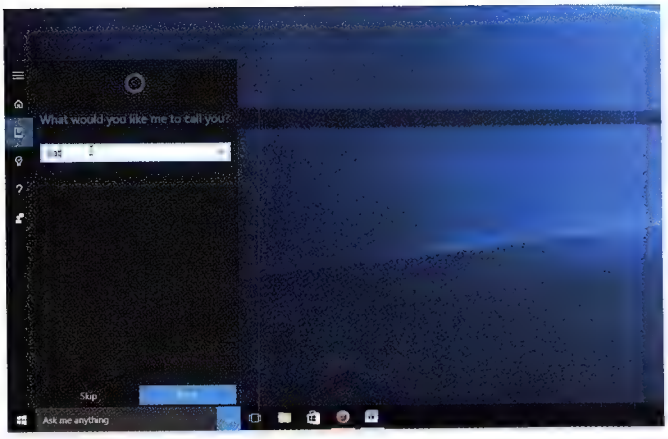
Cortana is great for converting currency and units of measure. Simply say 'Five Australian dollars in Yen', for example, and the answer will appear immediately.

Jargon buster!

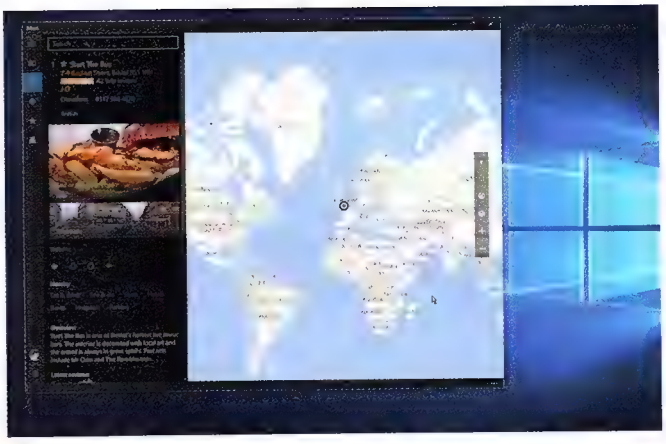
Cards
A card is an information box about a particular subject, tailored to suit your preferences.

Notebook
While they were creating Cortana, Microsoft's developers interviewed real personal assistants and found that most keep a physical notebook of important facts about their clients. Cortana does the same.

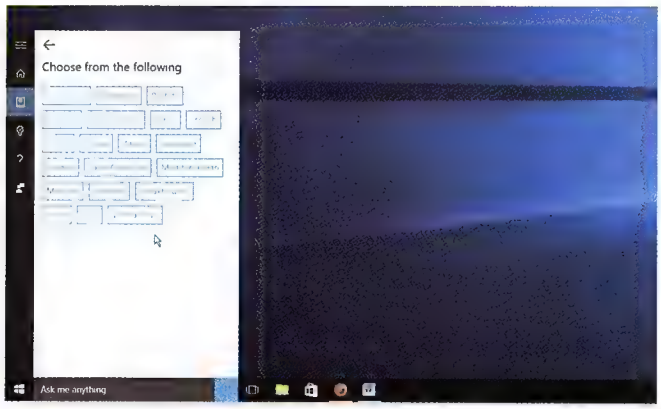
Google Now
Google's equivalent of Cortana — currently only available for phones and tablets using the Android operating system.



3 FILL IN THE BLANKS
Like any personal assistant worth their salt, Cortana keeps a 'Notebook' full of information about the boss — that means you! To fill in the blanks in this notebook and improve your experience with Cortana, click the third icon down in the menu on the left and choose 'About me'. Here, you can tell Cortana your name (and how to pronounce it, if necessary).

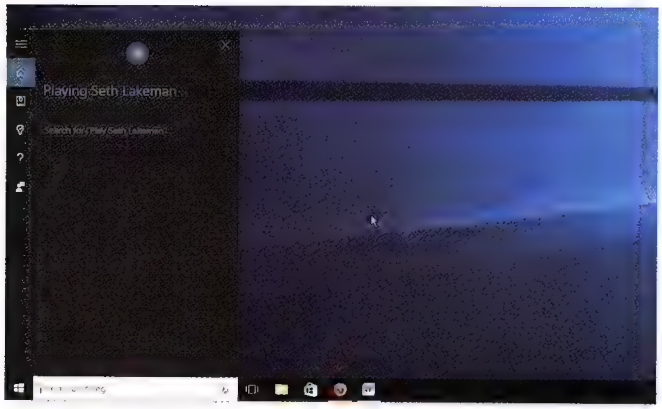


4 FAVOURITE PLACES
It's also worth adding some of your favourite places to the Notebook. These could include your office, friends' addresses, favourite shops and more. Once you've entered a place, you can click it for more information, including a map, contact details, reviews and prices (for shops, restaurants and hotels), directions from your current location, and other places to visit nearby.



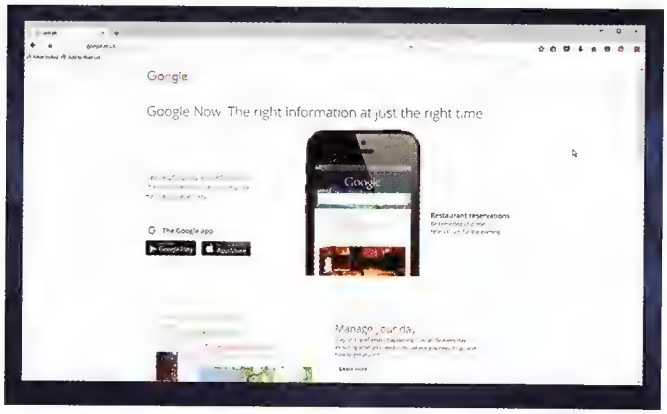
5 NOTEBOOKS AND CARDS

Giving Cortana details about your preferences will improve the quality of her search results and recommendations, so move through each of the topics listed in the Notebook and enter as much information as you like. Each of these subjects relates to a 'card' — a page of information relevant to your interests. Some of the settings are quite esoteric, but you can deactivate them.



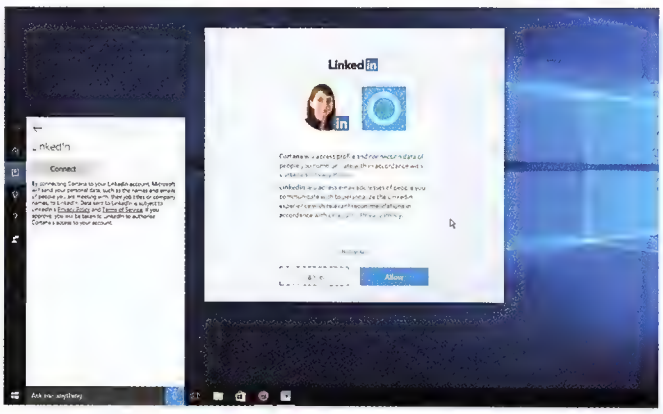
7 VOICE COMMANDS

To control Cortana with your voice, click the microphone icon beside the search box. Cortana will detect any microphones connected or built into your PC, and ask you to read a sentence aloud so it can adjust the input volume. You can then use commands like 'Play all my songs' or 'What is it like outside?' Plug in headphones or speakers to hear the responses.



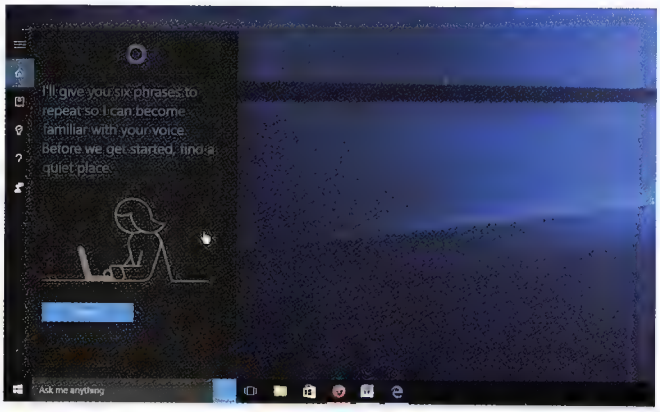
9 THE GOOGLE OPTION

Bear in mind that commands issued to Cortana will always be performed using Microsoft tools — so web searches and weather reports will use Bing, emails will use Outlook, music will be played using Groove Music. If you prefer to use Google Search, Gmail, Google Calendar and so on, you'll be better served by Google Now. However, Now is only available for mobile devices.



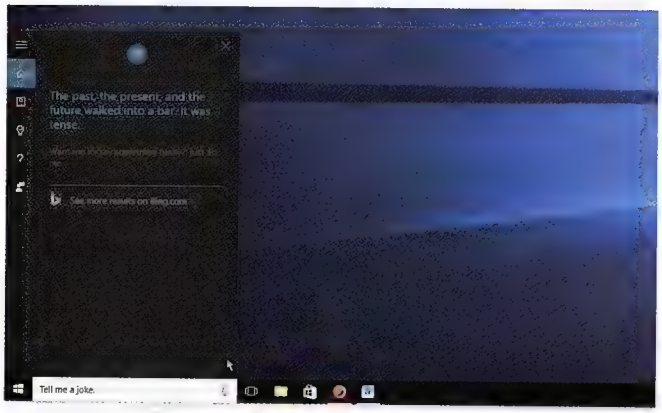
6 MAKE CONNECTIONS

You can make Cortana even more useful by connecting other accounts. For example, connecting your LinkedIn account can give you information about people you're scheduled to meet, and connecting your Xbox Live account will let you know when your friends are online and provide relevant information about the games you enjoy playing.


I'll give you six phrases to repeat so I can become familiar with your voice. Before we get started, find a quiet place.
Ask me anything

8 HEY CORTANA

Cortana's settings (found beneath 'Linked accounts' in the notebook) let you customise voice controls further. You can choose to activate the assistant by saying 'Hey, Cortana' (however, this will drain the battery of mobile devices more rapidly because the microphone is always on), and train it to recognise your voice to avoid it being activated by someone nearby.



10 TELL US A JOKE

Now that you've customised Cortana, try asking her a few questions, such as 'Is there a cafe near me?' 'What's in my diary for Friday?' 'What restaurants are nearby?' 'How long will it take to get to work?' or 'What is it like outside?' You can also ask to hear something funny, though the groan-worthy jokes might make you wish you hadn't.

FULL LIST: TOP 50 FREE GAMES

Dwarf Fortress (on the disc)
The Dark Mod (download from web)
Command & Conquer: Tiberian Sun (download from web)
Spelunky (on the disc)
The Elder Scrolls II: Daggerfall (download from web)
MASQ (download from web)
N V2.0 (play in browser)
Cave Story (on the disc)
Brogue (download from web)
Frog Fractions (play in browser)
VVVVVV: Make and Play Edition (on the disc)
Tribes: Vengeance (download from web)
Freeciv (on the disc)
Dr. Langeskov, The Tiger, and the Terribly Cursed Emerald: A Whirlwind Heist (download from web)
Barkley, Shut Up And Jam: Gaiden (on the disc)
Gravity Bone (download from web)
Zineth (on the disc)
The Expendabros (download from web)
Double Action: Boogaloo (download from web)
Canabalt (play in browser)
Battle of Wesnoth (on the disc)
Super Crate Box (on the disc)
Red Rogue (on the disc)
Candy Box 2 (play in browser)
Diaspora: Shattered Armistice (on the disc)
Sonic Dreams Collection (download from web)
International Jetpack Conference (download from web)
Bernband (on the disc)
Fistful of Frags (download from web)
Datajack (download from web)
Icarus Proudbottom's World of Typing Weekly (play in browser)
Nitronic Rush (on the disc)
Westerado (play in browser)
Digital: A Love Story (on the disc)
QWOP (play in browser)
Coloratura (play in browser)
No One Has To Die (download from web)
Toribash (on the disc)
One Chance (download from web)
Alien Swarm (download from web)
OpenTTD (on the disc)
Don't Take it Personally, Babe, It Just Ain't Your Story (on the disc)
Dungeon Crawl Stone Soup (on the disc)
Wonderputt (play in browser)
Warsow (download from web)
Skrillex Quest (play in browser)
Reprisal (play in browser)
Ultra Business Tycoon (play in browser)
Rhythm Doctor (download from web)
Anchorhead (play in browser)

APC & TechLife present:

PC Gamer's Top Free Games

Find out what's included on this month's free DVD + how to use it!

In conjunction with our sister publications *TechLife* and *PC Gamer* (www.pcgamer.com), this month, we've put together a special bonus DVD that contains a selection of the top free games for PC, which have all been cherry-picked by *PC Gamer*'s experts – so unlike many other free games, they're all actually fun to play!

Although we haven't been able to include every game on *PC Gamer*'s list, we've crammed as many onto the DVD as possible, which you'll find bound-in next to this contents page.

HOW TO USE THE DISC

Note that the DVD is actually more of an 'interactive feature' than a standard cover disc. While we may not have been able to include all 50 games, the full list – along with screenshots and our reason for liking each – is included on the disc. Where we haven't been able to provide a specific game (which, in many cases, is because the game is hosted online and is played in a browser), we've included a link to the game's site, where it can either be played directly or downloaded.

Thus, the games in the feature fall into three categories:

On the disc: You'll find the installer on this disc – just save the game file to your PC (either an EXE or ZIP file) and run from your local drive.

Download from web: Some games aren't freely distributable or were simply to big to squeeze onto our disc, so in these cases, we've included a link to the game's site where you can download the installer yourself.

Play in browser: These are web-based games that are hosted and played directly online – simply click the link and the game's website will open in a new browser tab and you can start playing immediately.

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Be kind to your users — smarter error handling in Excel

Helen Bradley explains how to trap errors and recover from them gracefully in your VBA code.

Runtime errors occur during program execution. They occur when an unusual combination of factors cause problems such as a user trying to open a file that doesn't exist or division by zero. While you may not be able to prevent an error from happening, you can prevent it from crashing your code. We'll look at two ways you can handle errors with grace in Excel.

A QUICK AND DIRTY FIX

The simplest way to bypass errors in your code is to use this statement:

```
On Error Resume Next
```

This statement should appear before the statement that causes an error or it won't work. For this reason, it's best to place this at the beginning of your code. Then if an error is triggered, the program will skip the line causing the error and continue at the next line. The problem won't be dealt with, it will just be bypassed and the program will continue to run. If another error is triggered, it will also be bypassed in the same way.

This error handling isn't an ideal solution because it may result in your program producing unexpected, unusual and just plain wrong results.

A MORE SENSIBLE APPROACH

A smarter way to handle errors is to exit the program gracefully when an error is encountered. You can do this using an On Error Goto [label] statement. To use this, you'll need to create a label in your code and then, if an error is encountered, the program will jump to the label and continue to run from that point forward. This ensures that the remainder of the code is skipped and will avoid the program producing unexpected results. If you place code in the label area, it will be executed if an error is encountered. You must also ensure that the code in the label area is only executed if an error is triggered — so you'll need to skip over that if no error occurs.

When handling an error, you can use the Err function to return the error number and the Error function to display the text associated with the error.

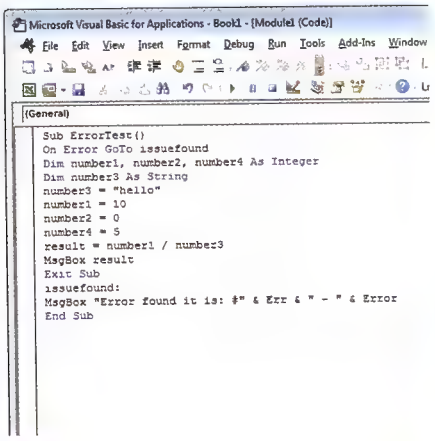
To see this at work, type this code into a new module:

```
Sub errortest()
On Error GoTo issuefound
Dim number1, number2,
number4 As Integer
Dim number3 As String
number3 = "hello"
number1 = 10
number2 = 0
number4 = 5
result = number1 / number3
MsgBox result
Exit Sub
issuefound:
MsgBox "Error found it is:
#" & Err & " - " & Error
End Sub
```

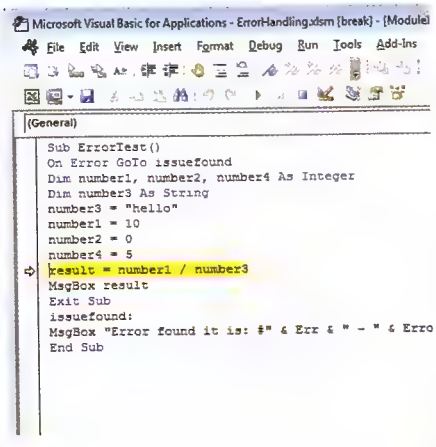
Run this macro from the Visual Basic Editor by clicking in the first line and press F8 to step through the macro. Change Number3 to Number2 in this line and run it again:

```
result = number1 / number3
```

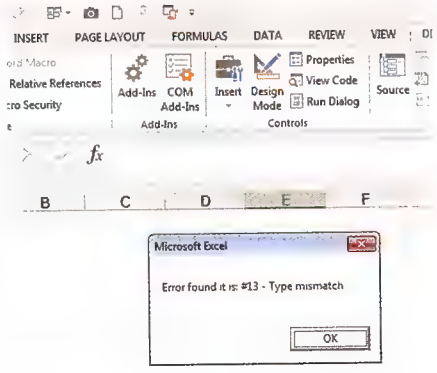
Finally, change 'number3' to 'number4' and test it. The program will handle each error neatly when it occurs and will skip error handling if there is no error.


Microsoft Visual Basic for Applications - Book1 - [Module1 (Code)]
File Edit View Insert Format Debug Run Tools Add-Ins Window
(General)
Sub ErrorTest()
On Error GoTo issuefound
Dim number1, number2, number4 As Integer
Dim number3 As String
number3 = "hello"
number1 = 10
number2 = 0
number4 = 5
result = number1 / number3
MsgBox result
Exit Sub
issuefound:
MsgBox "Error found it is: #" & Err & " - " & Error
End Sub

1 STEP 1
This is the sample code for testing Excel error handling.


Microsoft Visual Basic for Applications - ErrorHandling.xlsm [break] - [Module1]
File Edit View Insert Format Debug Run Tools Add-Ins
(General)
Sub ErrorTest()
On Error GoTo issuefound
Dim number1, number2, number4 As Integer
Dim number3 As String
number3 = "hello"
number1 = 10
number2 = 0
number4 = 5
result = number1 / number3
MsgBox result
Exit Sub
issuefound:
MsgBox "Error found it is: #" & Err & " - " & Erro
End Sub

2 STEP 2
Step through the code by clicking in the first line and press F8 to step through it line by line.



3 STEP 3
When an error is encountered, a custom message appears. ■

Effectively manage your iCloud Drive

Kenny Hemphill shows how to work with files across your OS X and iOS devices, and even recover what you've deleted.

Apple's relationship with online storage and syncing tools hasn't always been a good one. From iTools through to MobileMe, it made one misstep after another. Even when it first introduced iCloud, there was no easy way to use the service as cloud storage like you would Dropbox or OneDrive, for example.

That changed with the introduction of iCloud Drive. It's integrated into OS X's Finder, making it simple to add files to and retrieve them from your online storage. The iCloud Drive app added in iOS 9 (see below) allows for file management on your iPhone or iPad.

When it comes to working with your files, there's a handful of tips and tricks that are worth knowing. Moving them to iCloud Drive on your Mac is easy: drag and drop them onto its row in Finder's sidebar, or click that row and then drag and drop items onto a folder within.

The iCloud Drive app for iOS is largely straightforward, yet it provides several ways to get certain things done. It gives you two ways to view your files and folders: as large icons or in a list. To switch between them, go to the top level of your iCloud Drive, then tap the bulleted list icon at the top-right corner.

There are three ways to sort your files and folders: by date, name or tags. To use tags, you'll need to create and attach them in OS X, as there's no way to do so in iOS. In OS X, click iCloud Drive in Finder's sidebar, Control-click the file you want to tag, then choose Tags in the contextual menu. The easiest way to create tags is in 'Finder > Preferences > Tags'.

MOVE MOUNTAINS OF FILES

Back in the iOS app, the list view enables you to move a file by tapping the 'i' to the right of its name, then the toolbar's folder icon, and choosing a folder. You can move multiple files at the same time by tapping 'Select' at the top of the screen, then the items to move, and finally 'Move' at the bottom of the screen. A third option for moving files is to swipe left over a file's row in list view and tap 'More', then 'Move to Folder'. In icon view, hold a finger on a file, choose 'More' when the options bar appears, then tap 'Move to Folder'. The Select and swipe methods also let you delete files.

If you delete files from iCloud Drive, you can recover them for up to 30 days after deletion. See how to on the opposite page.

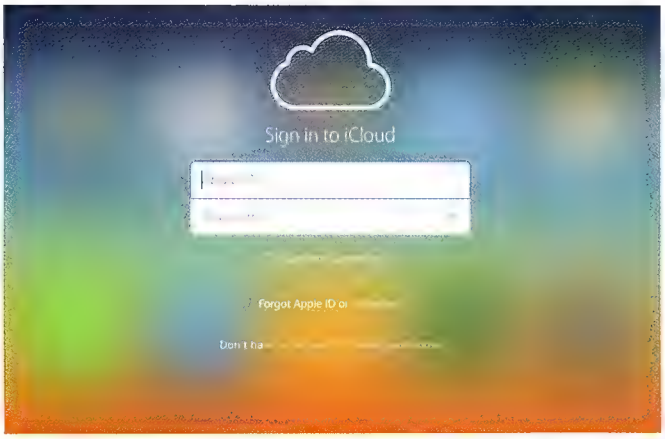
1 SEARCH DRIVE
Tap the search bar and then type to look for files and folders in iCloud Drive. Matching items appear below.

2 SORT THE VIEW
Swipe down past the first items listed to reveal sorting options. Tap one to sort the view on that attribute.

3 APP FOLDERS
Folders with icons are used by respective iOS apps to store docs. Mac apps are able to save outside of these.

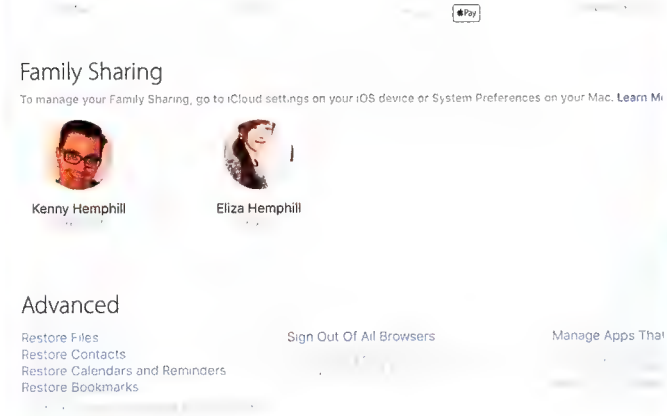
4 MANAGE ITEMS
Tap Select to add checkboxes that enable you to select multiple items and then move or delete them.

How to recover deleted files



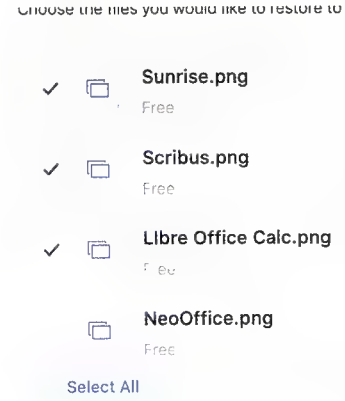
1 LOG IN TO ICLOUD ON THE WEB

To recover files you've deleted from iCloud Drive, sign in at iCloud.com on your Mac. Next, if two-factor authentication or two-step verification is enabled on your account, pick a device to receive a verification code.


Family Sharing
To manage your Family Sharing, go to iCloud settings on your iOS device or System Preferences on your Mac. Learn M
Kenny Hemphill
Eliza Hemphill
Advanced
Restore Files
Restore Contacts
Restore Calendars and Reminders
Restore Bookmarks
Sign Out Of All Browsers
Manage Apps That

3 VIEW DELETED FILES

Scroll down to the bottom of the page. Under the Advanced heading, you'll see four options, allowing you to restore different types of data. Click 'Restore Files' to see a list of files deleted within the last 30 days.

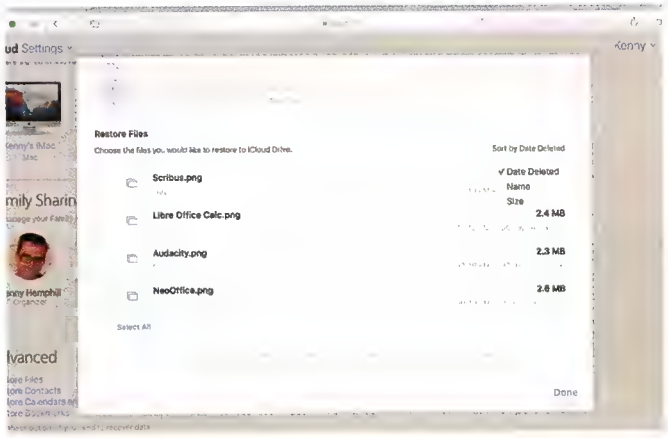


5 CHOOSE A FILE TO RESTORE

Once you've sorted the files the way you want, scroll down the list to find items you want to restore. Click the checkbox to the left of each's name. Alternatively, click the 'Select All' box at the bottom of the list. Click 'Done'.

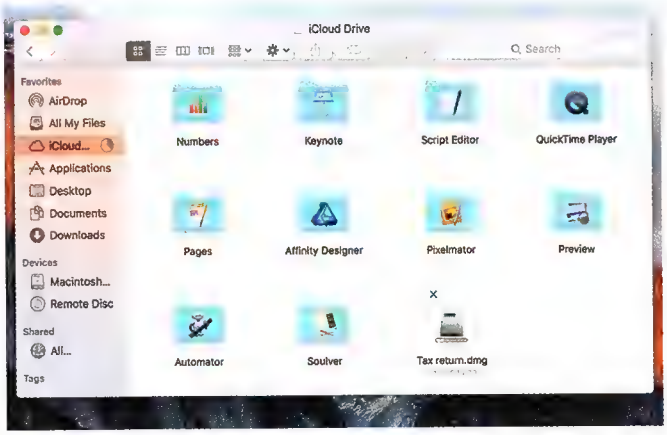
2 COMPLETE AUTHENTICATION

After you've picked a device, wait for the verification code to arrive on it, then type it into the box on the iCloud.com sign-in form. Once you're successfully signed in, click the Settings icon on the site's Home screen.



4 SORT AND SEARCH FOR FILES

By default, files are sorted by date deleted, with the most recently deleted at the top of the list. To sort them by name or size, click the 'Sort by' option at the top-right corner of the file list and pick an order.



6 SIGN OUT AND WAIT

Click your name at the top-right corner of the page, then Sign Out. Next, go to iCloud Drive in Finder on your Mac or open its app on your iOS device. Your restored file(s) should soon reappear there. ■

Share iPhone Live Photos as GIFs

Matthew JC. Powell shows how to make a cool feature more compatible.

Last issue, we used an iPhone app called Workflow to create single-tap speed dials for essential contacts. That was practical and all, but wouldn't it be good if you could direct that scripting power to something more... fun?

Well, you can.

If you happen to own an iPhone 6s, 6s Plus or an SE, you may be aware that you can take Live Photos – photos with a few frames of animation, sort of like the chocolate frog collector cards in *Harry Potter*. Live Photos are undoubtedly cool, and provide an extra level of enjoyment to your snapshots – but they are limited. Very limited.

Pretty much the main reason people take photos is to share them with people, and Live Photos basically can't be shared. Aside from users of iOS 9 or Mac OS X El Capitan or later, no one can view Live Photos in their native format. Facebook has started supporting Live Photos, but it's shaky at best, depending very much on how a given user is viewing Facebook.

If only there was some standard way of sharing short animations that was compatible with basically every computer on the planet...

Oh, yeah, there is – GIF!

By converting your Live Photos to animated GIFs, you can share them pretty much anywhere. You lose audio, of course – if you really want to share that three-second gem of a soundbite, you're stuck with Live Photo and its limitations – but that's really the only downside here.

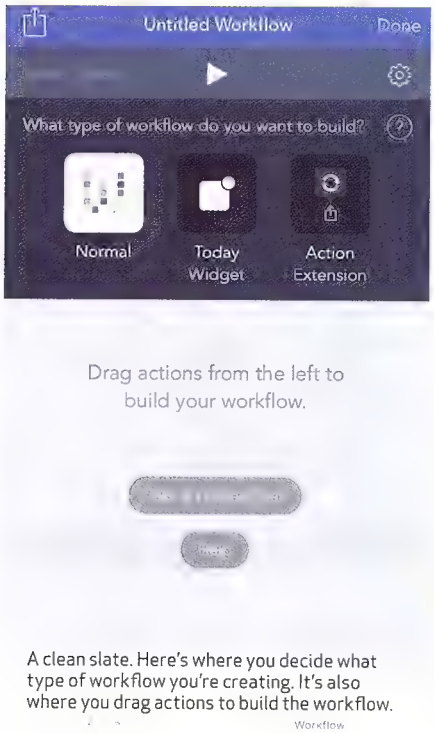
There are several apps for converting Live Photos to GIFs on the App Store, but if you have Workflow (which you should), you can build your own with just the features you want.

First, open up Workflow on your iPhone and tap the '+' symbol in the upper-right corner to create a new workflow. Next, slide your finger to the right, to reveal the list of actions available.

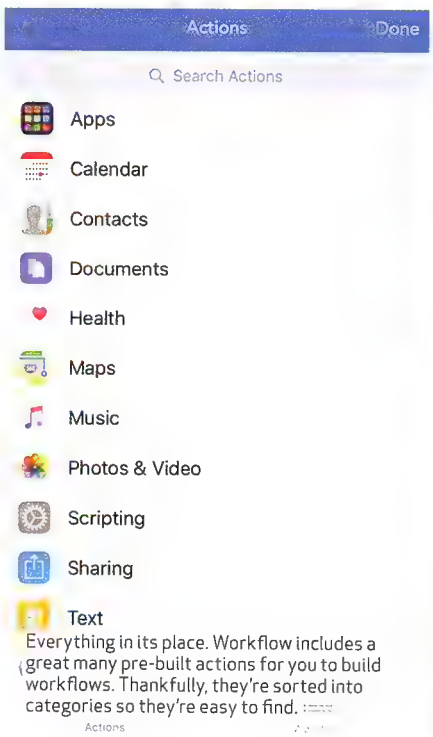
Under the 'Photos & Video' category, there's a subsection for Photos, where you'll find an action called 'Get Latest Live Photos'. This is actually exceedingly handy, since in iOS 9 at least, there's no easy way to tell whether a photo in your camera roll is a Live Photo or not. Drag that action to the right to add it to your workflow. When you do, you'll see that, by default, it offers to get 1 Live Photo. Use the + symbol to adjust this if you want to be able to work with more than just the most recent Live Photo you took.

Next, you'll want to be able to select which of the most recent Live Photos

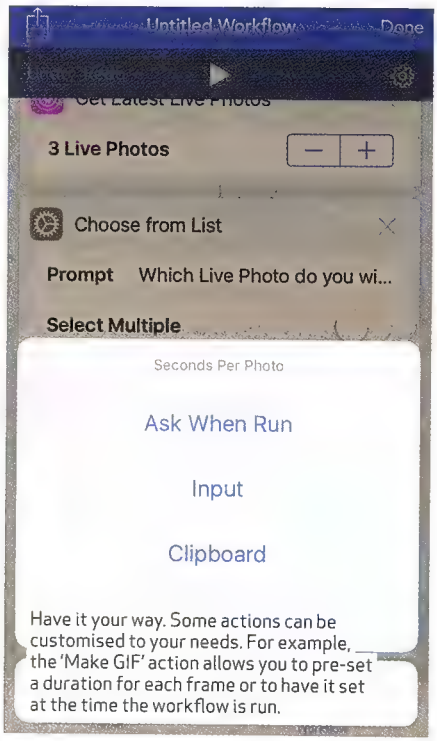
> "By converting your Live Photos to animated GIFs, you can share them pretty much anywhere."



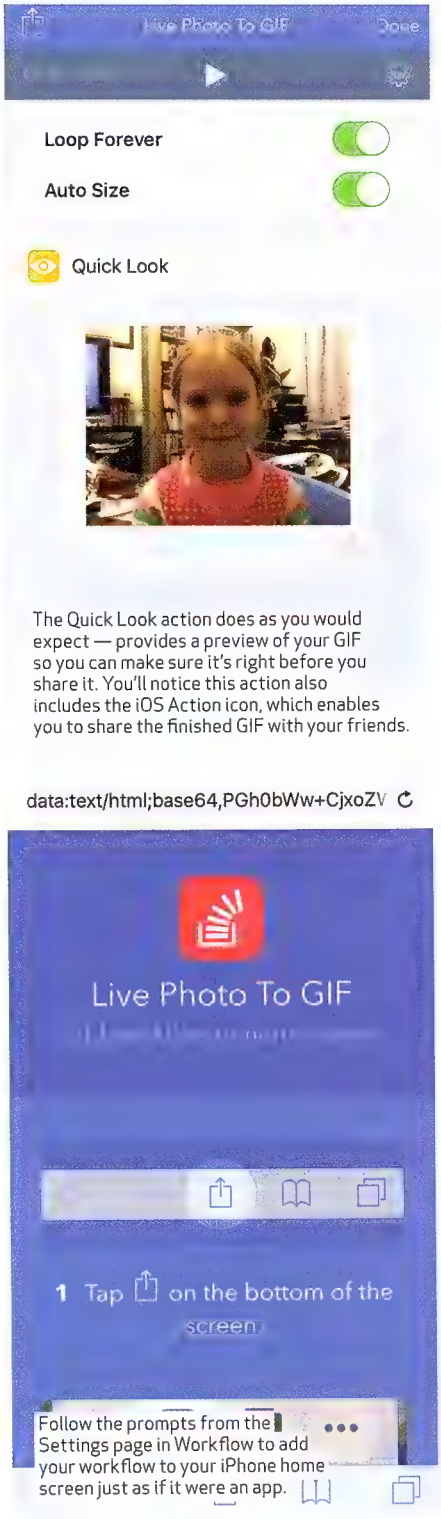
A clean slate. Here's where you decide what type of workflow you're creating. It's also where you drag actions to build the workflow.

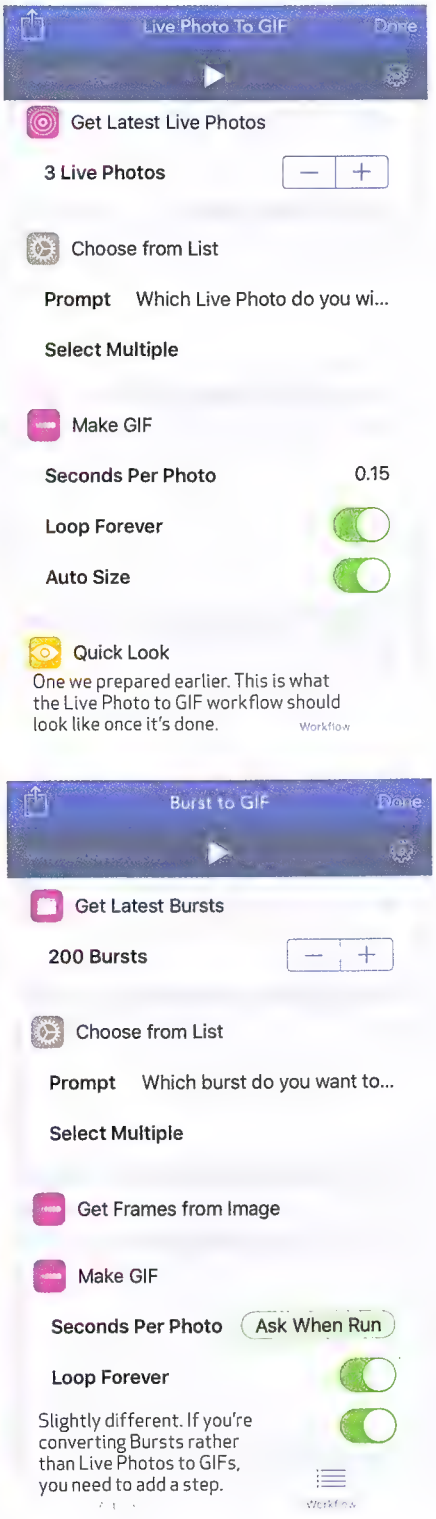


Everything in its place. Workflow includes a great many pre-built actions for you to build workflows. Thankfully, they're sorted into categories so they're easy to find.



Have it your way. Some actions can be customised to your needs. For example, the 'Make GIF' action allows you to pre-set a duration for each frame or to have it set at the time the workflow is run.




Live Photo To GIF
Done
Get Latest Live Photos
3 Live Photos
Choose from List
Prompt Which Live Photo do you wi...
Select Multiple
Make GIF
Seconds Per Photo 0.15
Loop Forever
Auto Size
Quick Look
One we prepared earlier. This is what the Live Photo to GIF workflow should look like once it's done.
Burst to GIF
Done
Get Latest Bursts
200 Bursts
Choose from List
Prompt Which burst do you want to...
Select Multiple
Get Frames from Image
Make GIF
Seconds Per Photo Ask When Run
Loop Forever
Slightly different. If you're converting Bursts rather than Live Photos to GIFs, you need to add a step.

you wish to convert. Again, go to the list of actions and this time look under the 'Scripting' category. In the subsection called 'Lists', you'll see 'Choose from List' – drag it over.

Now you have the option to write a prompt – a question to be asked when the list appears. You could follow Apple's user-experience guidelines and write something like "Which Live Photo do you wish to convert?" Or you could be a rebel and live by your own rules. We don't judge.

Next, go back to the actions list and the Photos & Video section, where you'll find 'Make GIF'. Drag that over and you'll see you have three options: 'Seconds Per Photo', 'Loop Forever' and 'Auto Size'. With the Seconds Per Photo option, the default is 0.15 but you can adjust that to your heart's content. You can also opt to ask each time you run the script if you don't want to be stuck with the same speed for every GIF.

Given Live Photos are only three seconds long, it might be worth stretching some of them out a bit for artistic effect.

Next, return to the actions list, find the Documents section and the action 'Quick Look'. This will give you a preview of your animated GIF once it's converted, so you can go back and adjust the speed before saving it. The Quick Look action also includes the Action icon (that is, the square with an arrow coming out of it) which enables you to share your GIF by email, Facebook or whatever means you see fit.

Finally, you'll want to save your new GIF-making app on your home screen where you can get at it. Tap on the cog icon near the top right-hand corner to open the settings screen. There you can give your workflow a name and an icon and add it to the Home Screen.

You can also, if you wish, make it into an 'Action Extension'. Then whenever you take a Live Photo, you can activate this workflow from within the Photos app by selecting the Live Photo and tapping on the 'Action' icon at the bottom of the screen.

OTHER FUN WITH GIFS

You may have noticed that, in the Actions list in Workflow, as well as 'Get Latest Live Photos', there is also an action to 'Get Latest Bursts'. Burst mode is a terrific option when you're photographing sports and kids and things that don't sit still well, but it's a pity that once you've chosen the frame that captured the perfect moment, the rest of them just get chucked.

Instead, why not make your bursts into animated GIFs?

All you have to do is follow the same instructions as above, but instead of Get Latest Live Photos, choose Get Latest Bursts. Also, since a Burst is multiple image files, not one single movie file like a Live Photo, you'll need to insert an extra action.

Find the action called 'Get Frames from Image' and drag it into your workflow in between 'Choose From List' and 'Make GIF'. That just tells Workflow to load all of the images associated with that Burst and use them as frames for the GIF.

The other difference is that if you're converting a Burst rather than a Live Photo, it won't work as an Action Extension.

Fix and enhance photos in Linux

Alexander Tolstoy shares best practices for handling your smartphone photos on Ubuntu and other Linux distros.

Have you ever wondered what you should do next after pressing the shutter button on your camera? With a set of helpful applications and utilities in Linux, you can add extra value to your images by enhancing them, fixing common issues and organising your workflow.

Nowadays, most people take photos with their smartphones while a smaller group still rely on their consumer-grade cameras, and as modern storage has grown to many gigabytes, many of us just store all our images on SD cards. Storing photos this way isn't a bad idea, of course, but there's a world of other amazing possibilities and that's where a little extra knowledge on image processing in Linux can be incredibly helpful.

We'll start with transferring photos from your device to a Linux machine and then proceed with other tasks.

TRANSFERRING IMAGES

Basically, there are two main ways that USB devices, such as cameras and smartphones, connect to a PC. These are Mass Storage mode and MTP mode. The first is the simplest and most obvious – you see your device as a mounted removable drive, while the second (media transfer protocol) requires extra integration in Linux desktops. Luckily, all main desktop environments have decent support for MTP and you'll hardly notice that your MTP-equipped device isn't a removable USB storage. For this tutorial, we'll be using the Nautilus file manager, being a popular choice in Ubuntu Unity and dozens of Gnome-centric Linux distributions (distros).

Of course, the simplest way to transfer images from your device to your hard drive is to use copy and paste. But this way can take a long time and bore you to death, especially when you need a lot of subdirectories for, say, each date when you shot your pictures. There are dedicated applications that do the job in a much easier way for you. One is Shotwell, the default photo organiser in Ubuntu and Fedora, another is Digikam, a Swiss Army knife of photo management with an advanced Import module and the third is Rapid Photo Downloader (RPD), which is a smaller tool that does what its name suggests.

The key feature of RPD is that you can set the naming convention to your liking (e.g. DDMMYY) and tell RPD to automatically transfer your images once you insert an SD card or connect a camera. The application will create all subdirectories according to given rules and will do everything for you. RPD is distributed as a Python package and it's distro-agnostic once you have all initial dependencies. For instance, let's install it in Fedora:

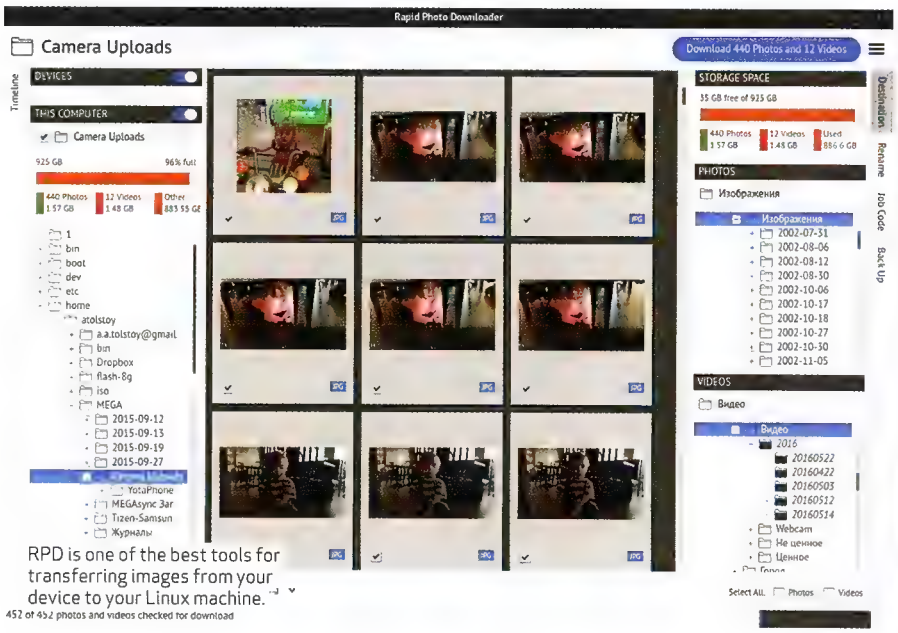
```
$ sudo dnf install python3-pip python3-wheel
$ python3 -m pip install --user --upgrade pip setuptools
```

To install RPD, download both the installation script and the tarball and then run as a regular user (i.e. without `sudo`):

```
$ ./install.py rapid-photo-downloader-0.9.0a2.tar.gz
```

RPD can auto-detect the source of images, based on previous attempts and watching for connected USB storage. Make sure to review downloading settings in 'File › Preferences' and enable extra features, such as photo backup (images will be copied to several locations at a time). When you're done, press the 'Download' button to start the transfer.

Sometimes, you will need to apply an edit or transformation to a lot of images, which, for some of you, may have meant doing lots of routines by hand. Luckily, you don't have to keep doing that and, in the following examples, we'll cover how to automate bulk actions.



RPD is one of the best tools for transferring images from your device to your Linux machine.

BULK ACTIONS

The first common action is resizing, e.g. you need to attach 20 images to an email, but the recipient doesn't need that many megapixels in each photo while the web server would simply reject a very big attachment. The easiest way to scale down your photos is to install the dedicated plugin for the Nautilus file manager. In Fedora, do it with the following command:

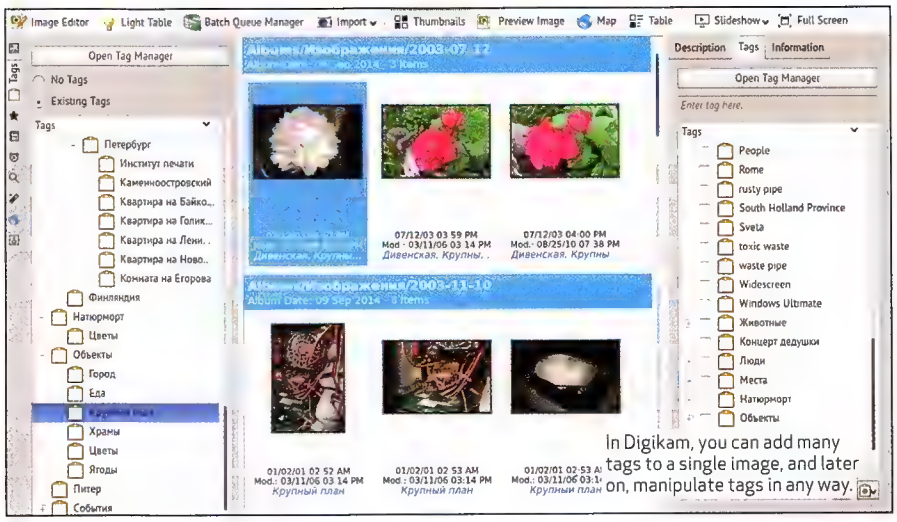
```
$ sudo dnf install nautilus-image-converter
```

There is a very similar (yet different) extension in Ubuntu, which you can get this way:

```
$ sudo apt-get install nautilus-image-manipulator
```

Whichever you install, don't forget to restart Nautilus (or simply log out and then log back in) for changes to take effect. Once you do that, select the scope of images you'd like to resize, right-click any of them and select 'Resize images'. Both Ubuntu and Fedora-centric Nautilus extensions provide nearly the same features: they enable you to specify the new size in pixels or percentage, choose to save new files along with the originals (non-destructive mode) and also apply a prefix to file names. As the names suggests, you can also mass-rotate images in the same way, just choose the appropriate item from the Nautilus right-click menu.

If you need more features for bulk actions, try Phatch — a photo-batch processor for Linux. Phatch can batch resize, rotate, apply shadows, perspective, rounded corners and duplicate directory hierarchies etc. It's also available in many Linux distros, including Ubuntu and Fedora, so install it in a convenient way via APT, DNF or from within a graphical package manager. Keep in mind that Phatch also has a special Nautilus integration extension called nautilus-phatch, which provides access to extra bulk actions from the Images context menu. In Phatch, pressing the big '+' sign adds actions to the queue. The list is quite extensive and you can also put several actions in one queue in any combination. Phatch enables you to be more creative with your images and add special EXIF tags, watermarks and do image transformation with a few mouse clicks. Don't forget to put the Save action in the end of the queue in order to keep the original images safe and secure.



In Digikam, you can add many tags to a single image, and later on, manipulate tags in any way.

Importing images the right way partially solves the problem and you instantly get a well-organised directory structure. With thousands of images being collected through a period of time, you may want to do a more specific search and sort them by places, dates, people or any other criteria. There are Linux applications that can do all of these things (and much more) by storing tags and other user-made metadata in databases. The most well-established photo organisers are Digikam and Shotwell. They are desktop heavyweights and, thus, are shipped with almost any Linux distro. Let's move on and look at how to sort and tag images in Digikam.

When browsing your images in Digikam, select at least one of them, right-click and go to 'Assign Tag > Add New Tag'. Enter the name of the new tag and optionally set the keyboard shortcut and that will allow you to seamlessly assign/clear that tag later on. When you're done, your tag will appear in the Recently Assigned Tags of an image's context menu. Sooner or later you will have many tags that need to be properly managed and reviewed. You can see the full tags tree either through context menu at 'Assign Tag > More tags' or by clicking on the tiny Tags button at the left-side panel in Digikam.

Initially, tags form a plain list, but they're designed to form a hierarchy. If you select a tag and create another tag in its context menu, it will be placed inside that parent tag, so that you can create complex trees, such as 'People > Relatives > Family > Brothers', or, say, 'Places > Vacation > Summer > America'. Of course, it takes some time and diligence to add tags manually, but it's worth it. Tags add extra features to your library and simplify image searches: you can browse the convenient list of date-based subdirectories with your images, but once you need to perform custom

The KDE way

There are many image-processing applications that integrate specifically into the KDE Plasma desktop environment and are worth mentioning. The KIPI-Plugins is a modular system that powers different KDE-related applications, such as the Gwenview image viewer and Digikam, and enables the impressive list of destinations where you can upload your photos. The Dolphin file manager can be extended using extra services that reside at **kde-look.org**. Go to 'Configure Dolphin > Services' to upload new stuff right from within Dolphin — such as KDE Services, a Swiss Army knife-style tool that includes a graphics converter and resize/rotate tool which work in Dolphin's right-click menu.

There's a great standalone application called Converseen that has a rich set of converting and resizing options for images. Converseen is based on Magick++ libraries and supports more than 100 image formats. It's a perfect tool for bulk actions with advanced features. Photo retouching is rarely done in KDE-centric applications, but you can happily do it in Krita. Even though Krita is focused on digital art, there are both Clone Brush and Healing Brush engines in brush settings, which enable you to remove objects and fix undesired effects. Go to 'Filter > Adjust' and select the proper tool for fixing colour levels, hue, colour balance and other things that potentially can improve your photos. The Filter menu has many more options, not as many as there are in Gimp (see over the page), but still enough for high-quality photo retouching.

searches (e.g. 'show me all pictures of my dad'), tags are your best friends.

Shotwell has a very similar approach to managing tags and it also has a very useful left-side panel with events, folders and tags tree. Shotwell is also considered a lot simpler than Digikam while being more suitable for novice users. Shotwell is more user-friendly and robust while Digikam sports some cool features that others do not, such as automatic face recognition and grouping photos by people.

If you shoot in the RAW format, you'll have to process your 'digital negatives' with a specialised software, such as Darktable for Linux. However, the majority of Linux users are more worried about what to do with their ugly smartphone photos, so we'll focus on fixing common issues of JPEGs that come out from your device already processed. Linux has a decent set of applications that can do the job, but the most viable solution is Gimp (GNU Image Manipulation Program). Gimp has all we need to fix brightness, saturation, hue and sharpness of your images, so let's load up an image in the app and roll up our sleeves:

Fixing broken colour levels

When an image is shot against the light, the subject may appear too dark. Go to 'Colors > Levels' and find three handlers below the graph. The centre handle balances the darker/lighter variants of the image while the left and right handle can discard parts of the colour range. Gimp shows a live preview of what your image will look like after you apply your changes.

Fix a skewed horizon

The power of Gimp is in its tools and now it's time for the Measure Tool. Of course, you just rotate the image by some rough degree, but it would be nice to know the exact angle, right? Select the Measure Tool and drag a line along the real horizon of the image. Take note of what has just appeared in the status area below the image. There you can see the precise angle, which you should enter in the rotating dialog.

Remove undesirable objects

One of the most valuable Gimp features is Clone Tool. Set the desired brush for it, with the correct size and smoothness, and you're ready to remove, for instance, random people on your image's background etc – use 'Ctrl-click' to select the source of cloning and then paint normally over the target area. But wait! Gimp has an even more advanced retouching brush – Healing Tool applies smarter heuristics and helps preserve texture and colour tones when cloning.

Make the image sharper

For years, Gimp has been offering two options for sharpening images: Sharpen and Unsharp Mask. Both are found under the 'Filters > Enhance' menu section. They can improve blurred or slightly unfocused image, but don't expect wonders from these tools. The good news is that you can attach the extra Refocus plugin (which you can find here: **refocus.sourceforge.net**) that uses a convolution matrix to restore details that were not recognisable before. When installed, Refocus also resides at 'Filters > Enhance'.

Fix white balance

Modern cameras use very smart algorithms for adjusting white balance, but they often fail when there's artificial lighting or several sources of light in the scene. The common problem here is the yellowish tone of skin colour, so let's fix it. Select the Color Picker tool and pick the most typical yellow colour that you want to remove. Create the new layer filled with that colour, then invert it ('Colors > Invert') to get the blueish colour and finally select Soft Light mode for the layer. You'll notice that the yellow colour has now been subtracted from the image – you can then play with layer opacity to adjust the amount of the effect.

Filters are another way to make your photos look artistic without too much effort. This time, we quit Gimp and turn to more compact tools. The first one is Gnome Photos, which gained support for filters in 3.20. Open the photo you'd like to process in Gnome Photos and choose the Pencil button on the top-right side of its header bar to go to the editing mode. The Filters section contains a number of trendy retro filters, such as 1977, Brannan, Gotham, Hefe and Nashville – which are all simulating respective film-like effects.

The alternative way is to use XnRetro – which is a dedicated application for applying retro-styled effects to photos. However, XnRetro isn't open source and it comes as a single universal 32-bit tarball for all Linux distros. This means you may have to satisfy XnRetro's missing dependencies manually (as well as hold your nose) but it shouldn't be too tiresome in most cases.

The main XnRetro window has the colour adjustment side-panel on the right, but that's not actually what we're looking for. The real sweet features are to be found along the lower part of the window. Here, XnRetro has a list of 20 retro-filters and most of them mimic historic photo film manufacturers. There are other tabs here, such as Light, Vignette and Frame, and you can combine effects from different categories and create a very stylish custom filter variation for your photographs. Note: The Square Output option is turned on by default – as it assumes that you want to have Instagram-style square photos and crops your images upon saving.

Exporting images

While it's perfectly fine to store your photo library on your hard drive, you might want to share you photos, screenshots, drawings or artistic collages with other people. Instead of doing everything by hand, consider using Linux applications that have built-in capabilities for publishing images. We'll start with Online Services,

The KDE way

You don't have to use a desktop environment in order to process images in Linux. When you want to escape, you can happily deal with images using command-line tools. Once you have ImageMagick installed on your system, you can manipulate images in many ways. Start with the display command to view images, like this:

```
$ display path/to/picture.jpg
```

Convert images from one format to another using the following syntax:

```
$ convert sunset.tif sunset.jpg
```

Explore the depth of the `$ convert --help` command and find out how to resize and rotate images as well. In the following example, we'll convert, resize and rotate our test image and also apply the charcoal filter to it:

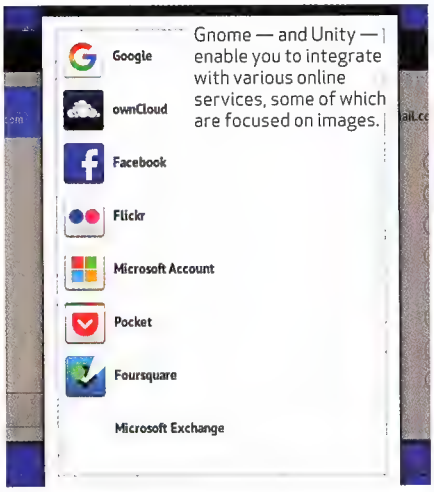
```
$ convert sunset.tif -resize 1024x768
-rotate 180 -charcoal 4 -quality 80 sunset.
jpg
```

If you need to do bulk actions on the command line, use Bash for applying a command to multiple files. For example, if you want to rotate all the images in the current directory while retaining the original files, you'll want to do this:

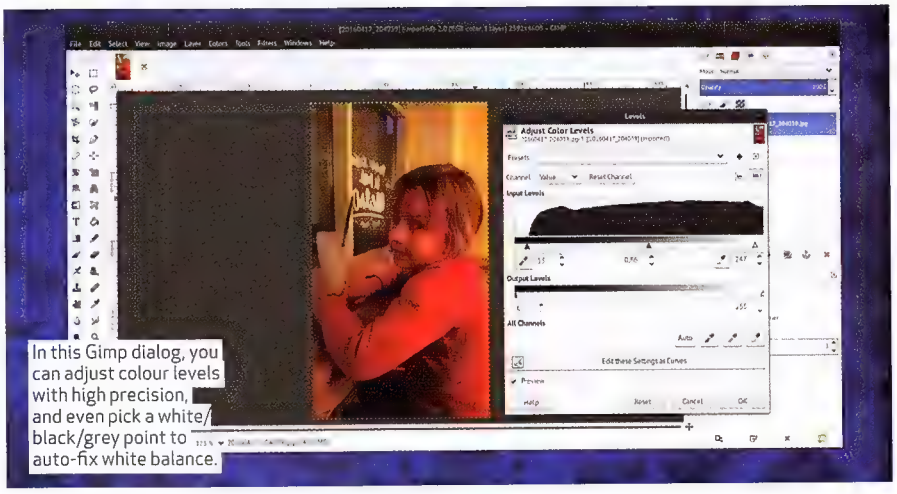
```
$ for file in *.tif; do convert $file
-rotate 90 rotated-$file; done
```

Or maybe we want to convert files to another format and resize them within one command:

```
$ for i in $( ls *.tif); do convert -resize
50% $i $i.jpg; done
```



Gnome — and Unity — enable you to integrate with various online services, some of which are focused on images.



In this Gimp dialog, you can adjust colour levels with high precision, and even pick a white/black/grey point to auto-fix white balance.

a configuration module, that can be found in Gnome and Unity. It provides system-wide integration with services such as Google, Flickr, Facebook, AIM and a whole lot more. Regarding image processing, we will probably want to connect to Flickr, a popular image-hosting website.

Once you provide the required credentials in the Online Accounts dialog for Flickr, you'll be able to see your published photos with the Gnome Photos application. To upload a new photo to Flickr, it's more sensible to use Shotwell's publishing feature. Select one or several images in the thumbnail view, then go to 'File > Publish' and select Flickr from the drop-down list. Notice that the list of available services in Shotwell's export dialog depends on how many accounts you connect in that system-wide Online Accounts setting, and even if you add them all, the list will still be quite limited. To enjoy more options, switch to Digikam. We've already mentioned that Digikam may seem overwhelming for new users, but when it comes to publishing images online, Digikam shines. You just select images, open the Export menu and there are over 20 different services that Digikam has specialised connection plug-ins for. These include services such as Imageshack, Imgur, Flickr, Zoomr, Picasaweb, Facebook Schwup, Yandex. Fotki and SmugMug as well as different alternative formats, such as Flash or local web gallery.

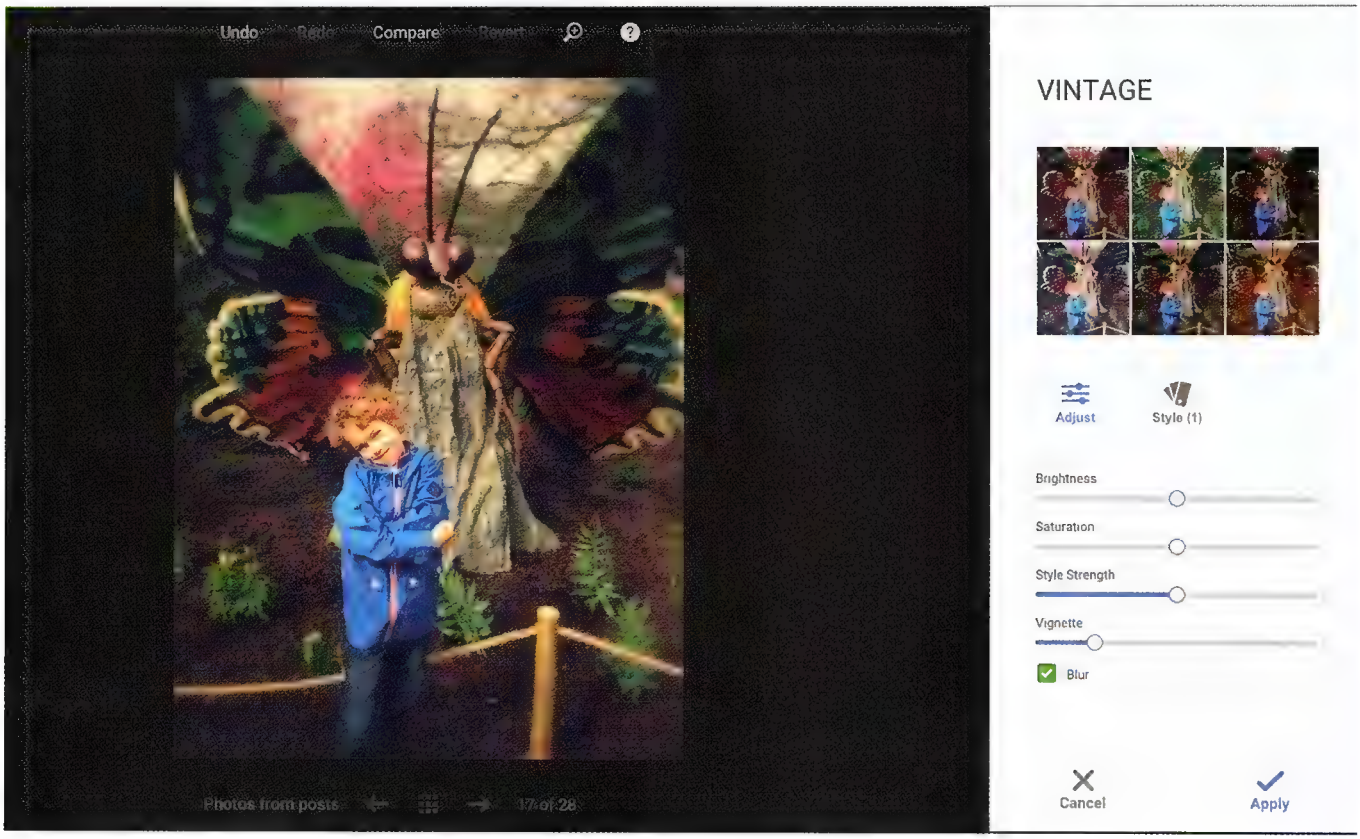
If you're not fond of Digikam and don't use Gnome or Unity either, there are several standalone tools that can be used for exporting images. First, take a look at Frogr, a Flickr uploader for Linux (**ppa:mariospr/frogr**). You don't have to use any sort of photo organisers to use Frogr, just select files from your directories and you're ready to go. For Facebook integration, try Bloom, which isn't open source but offers a free version (**antaki.ca/bloom**).

As images are just a type of file, the discussion about creating a backup copy of your photo library can look like a regular review of backup tools for Linux. However, there are special points to consider that are true specifically for images.

First, make sure you can do backups with software of your choice (Déjà Dup, Lucky Backup, KUP, Bacula and so on) and confirm that it's possible to extract photos from the backup copy. Then keep in mind that almost all backup tools compress files into archives, which is good for convenience, but doesn't save any space in the case of images (e.g. JPEGs are already compressed).

If you copy your image library to an external hard drive, putting the whole directory structure into an archive (even uncompressed, such as TAR) is strongly recommended. This is because copying one large file is a lot faster for your USB media than scrabbling with thousands of small files.

Another concern that some people miss is what files should be backed up. It's not just your ~/Pictures directory, but also settings and databases of Shotwell, Digikam or any other program you use. For instance, make sure you include the digikam4.db and thumbnails-digikam.db from your ~/Pictures directory as well a ~/.local/share/shotwell/data/photos.db. There's also the ~/.thumbnails directory. If you don't want to generate these thumbnails from scratch after restoring from backup, include it in your backup copy as well. ■



Store and share images with Google Photos

Graham Barlow shows how to make use of Google's free cloud storage to upload and share your photos with friends and family.

With its world-class reputation as a search engine and email provider, Google might not be the first thing to spring to mind as a place to store your photos online. Photo-sharing sites such as Flickr probably pop up first, but thanks to the way Google integrates everything and makes sharing easier than ever, it's become an option well worth checking out. Let's also not forget all that lovely free storage!

Google Photos has access to the 15GB of free space that Google Drive offers – and if you use Google Drive at work or school, then you could have 30GB of space available, or more.

Google makes it really easy to share photos, too, appearing as a folder in Google Drive, from where you can choose to share with fellow Gmail users or generate links that can be mailed to anyone. Of course, you might have no interest in sharing your photos at all. Google Photos can still be used just for private backup; in fact, it has a handy automatic backup option that will copy all the photos on your phone to the cloud. You need to be vigilant about what pop-up messages it gives you, however, and don't just click 'OK' without reading what it is you're agreeing to. Like most social networks, it's in Google's interest for you to share as much stuff as possible, and it will encourage you to share your photos at almost every opportunity. If you're a very private person, you'll probably find this annoying, but by being very careful about what you agree to, you can limit who your photos are shared with, and make best use of the service.

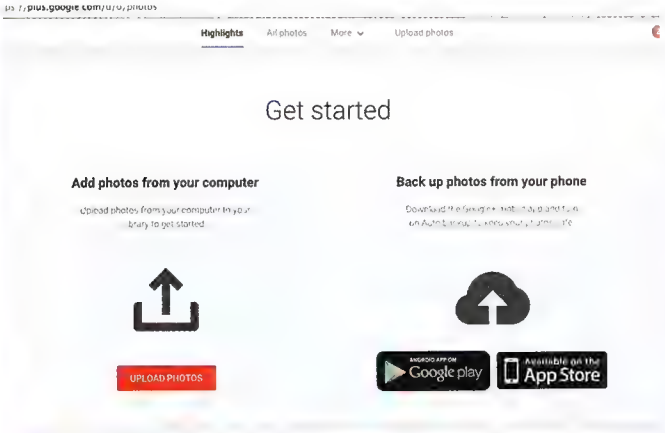
FINDING GOOGLE PHOTOS

The Photos section of Google is contained within Google Drive, so you're going to need a Google account to access it. If you've got a Gmail account, then you'll already have a Google Drive account, even if you aren't aware of it. Open the Chrome browser on your PC or Mac, and from the Google Drive page (**drive.google.com**) you can simply select Photos from the menu on the left-hand side of the screen.

The Google Photos service isn't just for desktops and laptops, though – you can access it on your mobile device using dedicated apps, both for Android and iOS, with ease. So you can shoot photos (or videos) on, say, your smartphone, then upload them to Google Photos immediately and enjoy them from any device. You might expect the more advanced features to only be available on devices running Google's own Android platform, but the Google Photos experience on an iOS device is the same as Android's.

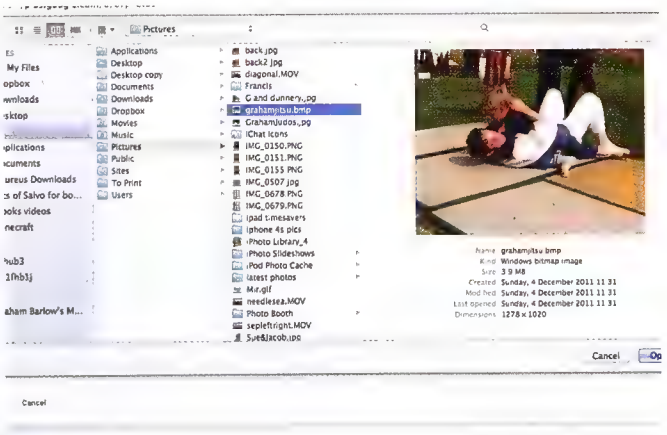
The biggest feature is found in the app's Assistant screen and is just called 'Movie' – it's a way of automatically taking your photos and video clips and creating a nice video that links them all together. You can also turn the best photos from your collection into an interactive timeline, complete with

Upload photos to share with friends



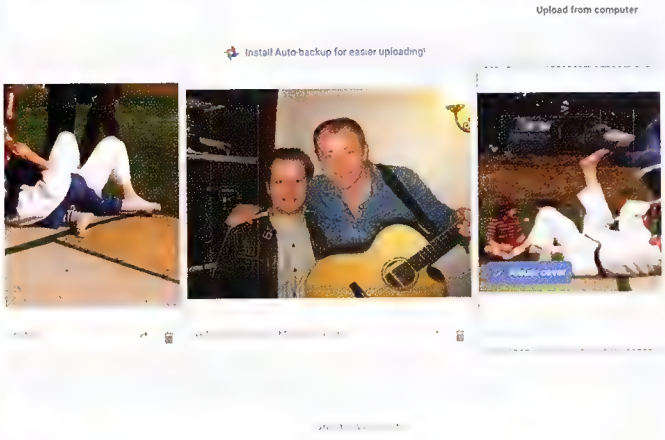
1 GETTING STARTED

To use Google Photos, go to your Google Drive account page (**drive.google.com**) and choose 'Photos' from the menu on the left-hand side of the screen. This takes you to the Get Started screen, which gives you two options — add photos from your computer or your phone.



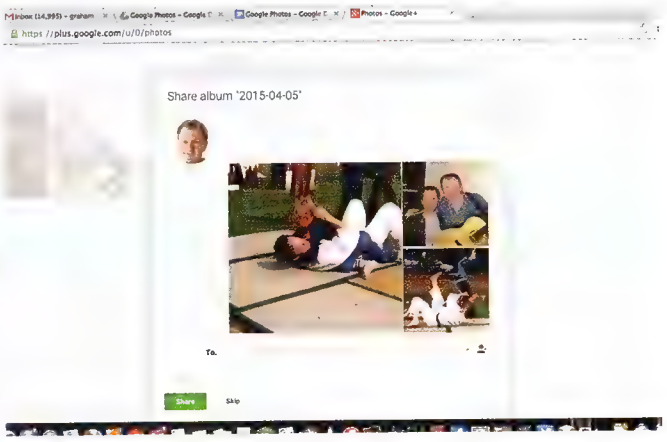
2 ADDING PHOTOS

You can drag and drop photos from a computer into your browser window to add them, or using the Google Photos phone app, you can automatically back up any pictures you take on your phone. It's available for Android and iOS.



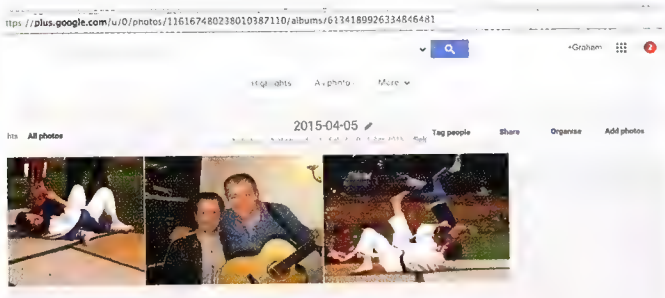
3 ADDING CAPTIONS

Once you click 'Open', the selected photos are uploaded. Be aware, this isn't a particularly quick process! Once they're uploaded, you can add captions, and choose which will be the album cover — just hover your cursor over a picture to select this.



4 SHARE THE ALBUM

Click 'Done' once you're ready. Google will locate faces in your photos and ask you to tag people from your Google contacts. The album will be shared automatically with anybody you tag — skip this if you want. You can also share with others.

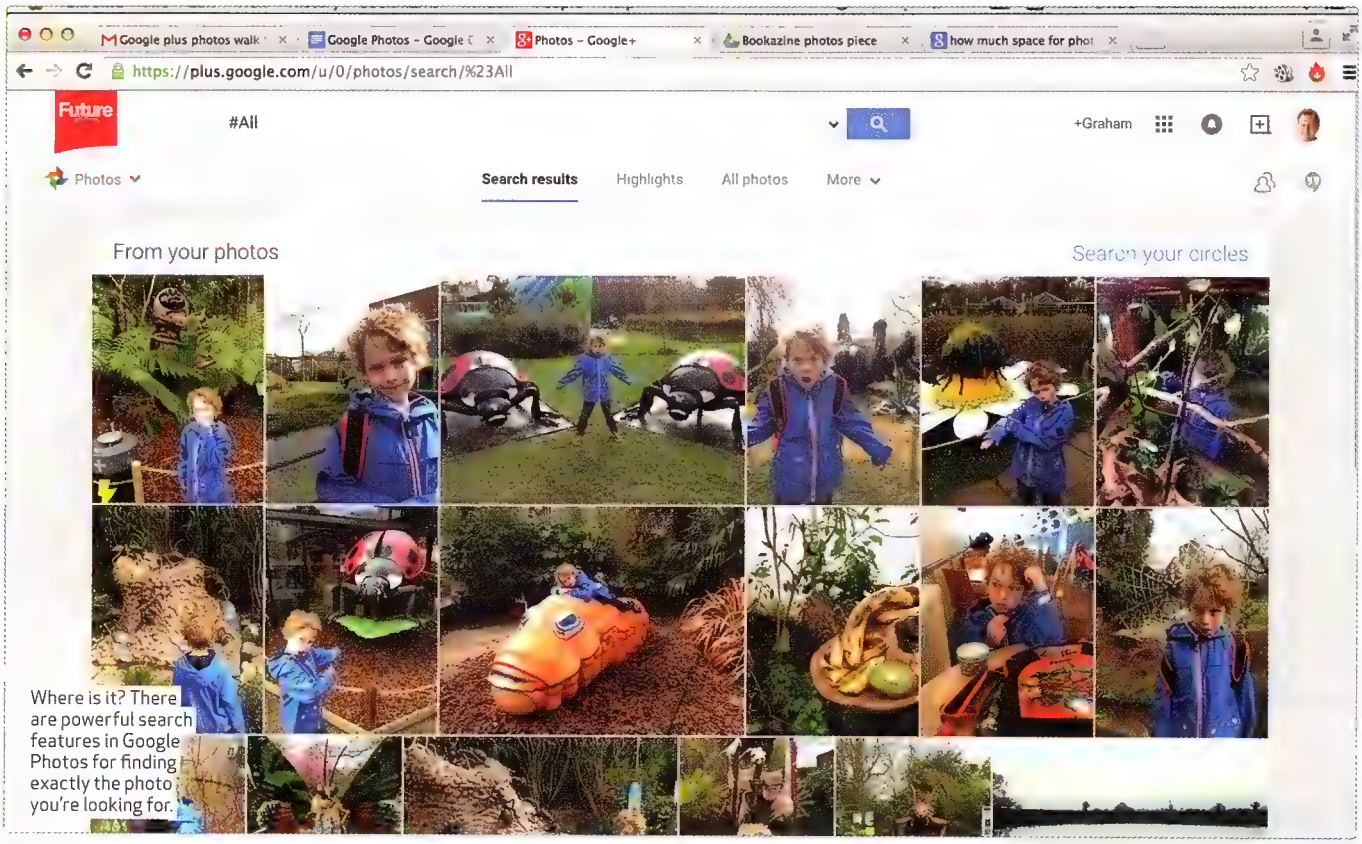


5 EDIT THE ALBUM

Now you'll see how your album looks on Google Photos. By default, it's given the date as its name; to change the name, click the pen icon next to it. You can also see options here to share the album, tag people, make a slideshow, download and delete photos.

6 EDIT PHOTOS

Google Photos offers some basic editing tools and filters. Click a photo, then click 'Edit', or any of the tools such as the the Crop tool, to get at the editing screen. You can crop, straighten, rotate or apply a photo filter.



Where is it? There are powerful search features in Google Photos for finding exactly the photo you're looking for.

"Turn your best photos into an interactive timeline with locations from Google Maps."

locations from Google Maps, showing where the photos were taken. While these features are nice, they're not the killer reason for using Google Photos. Instead, here, we'll focus on the meat of the subject – how to get your photos off your PC or phone, store them online, and share them with friends.

Google Photos also contains some editing options for your photos, including Instagram-style filters you can add to make them better (or at least, different!) almost instantly. Having your photos automatically backed up to Google+ Photos means that you'll always have a copy, even if you've lost your phone.

To turn on automatic photo backup with Google+ Photos, you'll need to install the Google+ app on your smartphone. See far right for a three-step walkthrough that takes you through the process on an iPhone. If you're lucky, your Android smartphone will already have the Google+ app installed, but you can always install it from the Google Play store if not.

SHARING YOUR PHOTOS

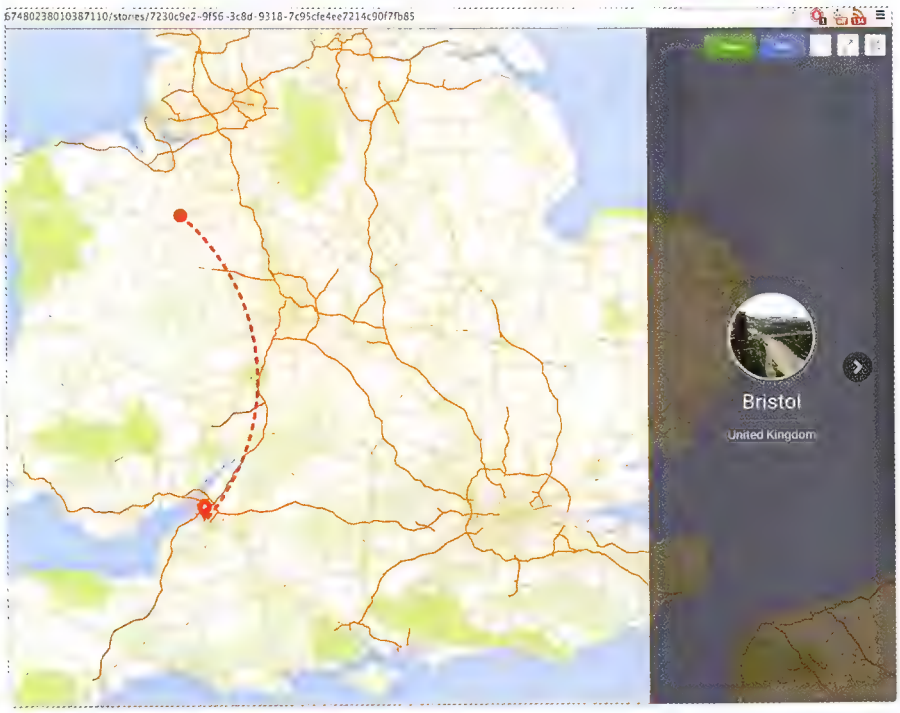
Once you've got your photos uploaded to Google Photos, it's time to see what you can do with them. The most obvious thing you'll want to do is share them with friends and family. You'll be given various chances to share them as you upload them to Google Drive; however, if you miss your chance, then you can always select the photo from your photo library, and investigate the sharing options.

When looking at a single photo, click or tap 'Share'. This gives you a chance to write a caption for the photo, and offers you options about who you can share it with.

As you'll know if you already use Google+, it uses various Circles to make sharing more selective. When you share a photo, Friends and Family Circles may be selected by default. You can easily add them by clicking or

Photos in Drive

You've had the ability to upload photos to your Google+ account for a long while now, but Google added Google+ Photos to Drive (**drive.google.com**). This means there's now a new folder in your Drive called Google Photos. Some time after the 6th of April 2015, when you logged into Drive, you were given the option to add the folder. If you missed it and didn't add the folder, you can add it in 'Drive Settings > General options'. The folder contains all the photos you've uploaded to your Google+ account (and, of course, holds subsequent uploads). The Google Photos folder in Drive acts like any other folder — you can rename, move or share it as you like.



tapping the 'To' field. You can also add individual people here from your Google contacts list.

If you care a lot about privacy, then we suggest you click the downward arrow that's also at the far right-hand edge of the 'To' field. This gives you a menu with two important options – 'Disable comments', and 'Disable reshares'. Disabling the reshares is key to making sure the photo isn't available to people you don't know.

There's also a little tickbox at the bottom of the form called 'Also send email from you...' which will email people to tell them that you've shared a photo with them. Turn this on or off, as required.

If you want to share more than just one photo at a time, then head to the Highlights tab in Photos. Here, you'll see all your photos broken down by event or album. Next to each event or album, there's a button called 'Share'. Click this and you'll get the same options you would for sharing an individual photo, but you're sharing the whole photo group.

MAKE YOUR PHOTOS SPECIAL

As well as backing up and sharing your photos, the final thing that Google+ Photos is really good at is making them look better. Google+ Photos doesn't have a full editing suite, but it has the tools you'd use most often – cropping, rotatation, adjusting, enahancing and filters. The crop, rotate, enhance and adjust features are pretty self-explanatory, while the idea of filters (called 'Styles' here) will be instantly familiar to anyone who's used apps such as Instagram.

Styles enable you to add cool effects to your photos, making them appear more mean and moody, or as if shot on a retro camera from the 1970s. What's nice about the editing options is that a copy of your original photo is always preserved, so you can add as many effects as you like, safe in the knowledge that you can always return your photo back to its original state, at any time.

There are many Styles on offer, but we found the 'Black & White' options, along with the selection in 'Vintage', to be particularly effective. The Tilt-Shift Style is very good as well. If you apply it to a shot of a city taken from high up, then it can make it look like a tiny model city. Try it!

Overall, Google Photos offers plenty of powerful storing, editing and sharing features for absolutely zip. If you haven't already taken advantage of it, then we suggest you do, as there's simply nothing to lose.

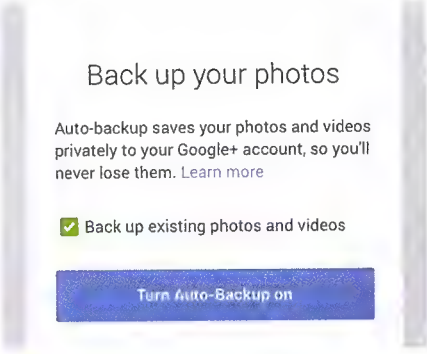
Graham's best tips

- When you upload photos from your phone to Google Photos, portrait shots often appear as landscape. Fix this by using the 'Rotate' options in the Edit screen.
- It's actually really easy to organise your photos! If you've uploaded a number of photos at once, you can add individual captions after the event — just click on 'Organize' once the upload is complete.

Upload photos

1 DOWNLOAD THE APP FOR IOS

On your iPhone or iPad, head to the App Store and search for 'Google Photos'. This is the app you need, and it will enable you to access all the functions of Google Photos, including the editing features. It's totally free. Once the app has downloaded and installed, open it to get started.


Back up your photos
Auto-backup saves your photos and videos privately to your Google+ account, so you'll never lose them. Learn more
Back up existing photos and videos
Turn Auto-Backup on

2 TURN ON AUTOMATIC BACKUP

Tap 'Get started' and choose a Google account to use with the app. If you have several, they'll all be listed here. Once you've done this, you will get asked if you'd like to turn on automatic backup. This will save all your photos and videos privately on your Google account.

3 SHARE PHOTOS

Backing up hundreds of photos will obviously take a long time, and if you don't choose to do it now, you can always choose to do it later. Alternatively, you can select individual photos to upload. You can share the photos with your Google+ circles, too. Choose one when you upload them.

Build a Pi-powered selfie machine

Les Pounder makes a great attempt to persuade us that selfies are artistic and, in the process, shows us how to use the Pi to create selfies with a twist.

The Raspberry Pi Foundation recently released a new version of its popular camera attachment. In this tutorial, we'll use the camera to create a special effects selfie machine. This project will also work with the older Raspberry Pi Camera and all versions of the Raspberry Pi with a camera port. As well as the official Pi Camera, you need a breadboard, a momentary switch and a female-to-male jumper wire. All of the code for this project and a detailed diagram of the circuit can be downloaded from bit.ly/PiSelfieCamera.

To install the Pi Camera, first, we need to ensure that our Raspberry Pi is turned off and locate the camera port, which is between the HDMI and Ethernet port. The port has a pull tab, which you'll need to pull upwards until it can go no further. Now insert the ribbon cable of the camera into the port, with the blue side facing the Ethernet port. The ribbon will only go so far and, when ready, push the port tab back into place to secure the ribbon cable. While our Raspberry Pi is off, let's connect the button that will be used to trigger our camera. Please refer to the diagram (see opposite page) for instructions on how to wire up your button. Next, attach your keyboard, mouse, HDMI and any other accessories to your Pi, and power up and log into the desktop. We now need to tell our Raspberry Pi that we have connected the camera. In the main menu, located in the top-left of the screen, go to the Preferences menu and select the 'Raspberry Pi Configuration' app. In the application, click on 'Interfaces' and enable the Camera. To effect the change, you'll need to reboot your Raspberry Pi and you will be prompted to do so.

Once your Raspberry Pi has rebooted and returned to the desktop, open a terminal, you can see the icon for this in the top left of the screen. We are going to use a terminal command to test that our camera is working correctly. In the terminal type:

```
$ raspistill -o test.jpg
```

You will see a preview window appear, frame your picture and, in five seconds, the test will be completed and will save an image to your home directory. If any errors are encountered, then repeat the previous steps.

Inserting the camera cable into the port can be a little tricky.

SELFIE MACHINE

We now start our project. Our goal is to create a selfie machine that will produce a random artistic effect to the photograph. We will be using Python 3 editor, found in the programming menu. When the Python 3 editor window opens, click on 'File > New' to open a new blank window. Immediately save your work by clicking on 'File > Save' and call the project **selfie_camera.py** and you'll find that subsequent saves will be quicker.

Our first section of code contains a series of imports, which enable our project to work with Python modules and add access to more functionality:

```
from time import sleep
from random import choice
from picamera import PiCamera
from gpiozero import Button
```

We import the `sleep` function from the `time` module, this enables our project speed to be controlled. Next, we import the `choice` function from the `random` module, using `choice`, we can randomly choose an item from a list. Our third import is the `picamera` module, which we rename to `PiCamera`. Last, we import the `Button` class from `gpizero`.

With our imports complete, we now go on to create two variables:

```
camera = PiCamera()
button = Button(17)
```

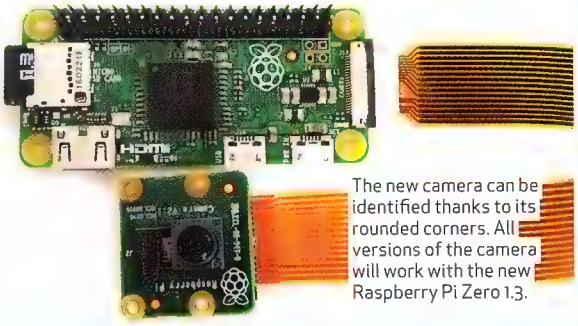
Our first variable, `camera`, is used to shorten the module reference for `PiCamera()`. Our second variable is `button` and we use that to store a reference to the GPIO pin that is used for our momentary switch. Our next line of code will start a live preview from the camera. In a similar fashion to seeing a preview shot on our smartphone:

The new camera

News of the new Pi Camera caught many off guard but its arrival was very necessary. The new official camera is both an improvement on the original and a replacement. The original's sensor, an OmniVision OV5647, has reached the end of its life, so the Raspberry Pi Foundation bought up all the remaining stock, so stocks of the original will be limited.

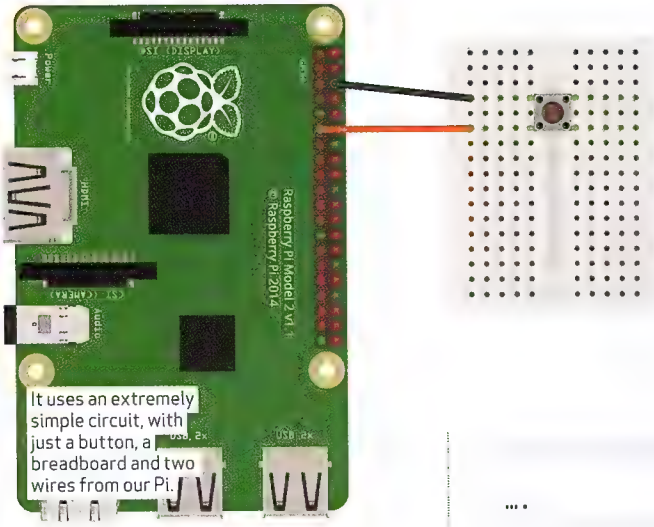
For the second version of the camera, we see a new Sony IMX219 sensor which offers an impressive 8-megapixel still image at 3,280 x 2,464 pixels, which sits in contrast with the original camera's 5-megapixel 2,592 x 1,944 pixels. Both cameras can capture 1080p video at 30fps, 60fps at 720p and a whopping 90fps at 640 x 480 pixels, which makes them ideal for filming high-speed video in the classroom.

The new camera, with its rounded edges, comes in two versions: a standard camera, as used in this tutorial, and a noir version which can be used with an infrared LED to capture images and video in low-light conditions. Both are compatible with all versions of the Pi that have a Camera port, and this includes the Pi Zero v1.3.

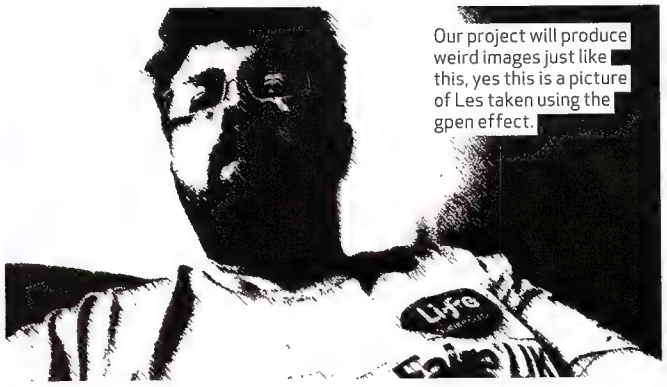


The new camera can be identified thanks to its rounded corners. All versions of the camera will work with the new Raspberry Pi Zero 1.3.

All of the cameras work with the PiCamera Python module, which will enable existing projects to work with the new camera and for future projects to be backwards compatible with older cameras. The new camera can be identified thanks to its rounded corners.



It uses an extremely simple circuit, with just a button, a breadboard and two wires from our Pi.



Our project will produce weird images just like this, yes this is a picture of Les taken using the gpen effect.

```
camera.start_preview(alpha=192)
```

You will see that we use the argument `alpha = 192` as this enables a transparent effect on the preview, just in case we have an error and so we can see the desktop.

Our next line of, very simple, code is a variable called i: `i = 1` , which will store an integer, in this case `1` . We will use `i` to count the number of photos that are being taken.

We now move on and create a list that will store the special effects options available for the camera. There are quite a few of these and, in the code snippet, we will only show a few, but the full list is available in the download for this project.

```
effects = ['none',
          'negative',
          'sketch',
          'denoise',
          ....
          ]
```

We've reached the main section of code for our project, which controls how our selfie machine works. All of the code is enclosed in an infinite loop: `while True:` . Our first line of code inside the loop is designed to wait for the user to press the button/momentary switch attached to pin 17:

```
button.wait_for_press()
```

You'll note that we've used the variable button to store this location earlier.

Once the button has been pressed our code will create a new variable called effect and in there we will store a randomly chosen special effect from our list of effects that we created earlier. Each time the loop runs it will choose a different effect, but as the list is quite small, there will be duplication: `effect = choice(effects)` .

With the special effect chosen, we now apply that choice and instruct the camera to use that effect: `camera.image_effect = effect` . To confirm that we have chosen a new effect, we print the name of the effect to the Python shell with:

```
print('This effect is',effect)
```

Next, we instruct the camera to capture an image and save the image to the desktop.

```
camera.capture('/home/pi/Desktop/image%d.jpg' % i)
```

You will see that we give each photo taken an incremented filename. We do this using the `i` variable that we earlier created. We use a substation template, in this case `%d` , which is a decimal/whole number (1, 2, 3 etc), we instruct the template to substitute the `d` for the value of our variable `i` .

We now increment the value of `i` so that it progresses to the next number in the sequence with: `i = i + 1` . Last, we come out of the infinite loop and ensure that the camera preview window closes if the loop is broken using: `camera.stop_preview()` . With the code completed, ensure that it has been saved. From the Python editor window click on 'Run > Run Module' to run the project. Get ready to smile and take a lot of funny photos.

ARM's 2017 CPU roadmap

Next year's mobile tech is all about power efficiency, 4K panels and mobile virtual reality. Darren Yates looks at ARM's new CPU and graphics core lineup for 2017.

You mightn't be ready to splash out a couple of grand for a shiny new Samsung Galaxy S7 Edge, but you can still admire the horsepower the latest smartphones have to offer. Look at some of the benchmark results for this and other current-generation flagship models and the numbers are pretty impressive.

But there's another reason to stand up and cheer these top-drawer models – they make the fractionally slower mid-range models that much more affordable for the rest of us.

The vast bulk of that Android performance comes courtesy of ARM, CPU designer to the stars and licensor of its core tech to dozens of other brands that make the chips inside your favourite mobile devices. ARM recently announced updates to its core roadmap, making this a great time to see what will power Android devices over the next 12 months.

CORTEX A73 'PREMIUM' CORE

The most recent news from the chip designer was the announcement of the new Cortex A73 core, codenamed 'Artemis' (**tinyurl.com/apc431a73**). This new design effectively replaces the Cortex A72 and should begin appearing in new devices early in 2017.

Back in 2015, ARM announced its latest top-drawer CPU design, the Cortex A72, to appear in two versions – the first, manufactured at the current 28-nanometre (nm) scale and a second '2016' vintage to be bottled using a much smaller 16nm process.

The new Cortex A73 is said to be 30% faster than the A72, while up to 30% more power-efficient. Part of this will be thanks to a jump in the maximum clock speed ARM can now extract from its core design. While the A72 managed a peak of 2.5GHz, the A73 will top 2.8GHz (some reports suggest 3GHz might be possible).

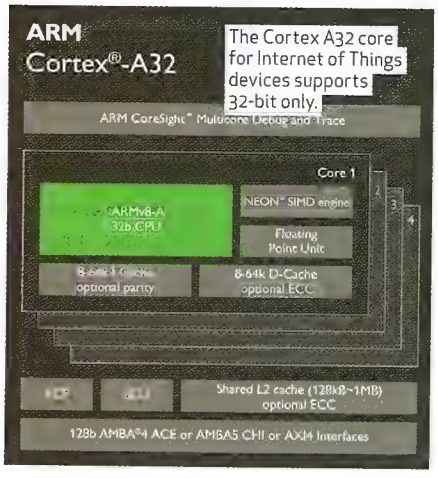
However, the extra speed, along with that 30% power efficiency gain, will come, at least in part, from the smaller manufacturing scale – just 10nm. According to ARM, that translates to one Cortex A73 core being just 0.65-square-millimetres in size. The full-stop at the end of this sentence is about the size of it.

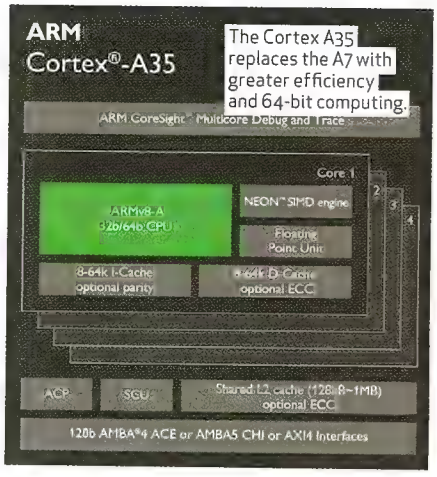
The A73's production has been designed for 10nm, but it's also possible that actual production could mirror the A72 with a dual-scale manufacturing timeline – initial A73 cores manufactured at either 16nm or 14nm process this year, while the ultra-tiny 10nm cores wait until 2017. Either way, scale shrinking only gets you part of the way.

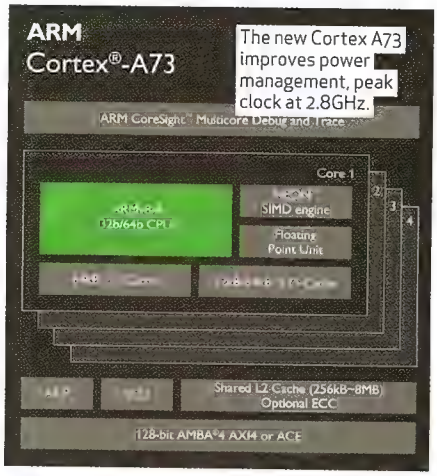
The Cortex A9 core inside the Galaxy S3 and Apple's iPad 2 put ARM on the map. But since then, the increased performance in newer-generation releases, particularly those out of the top drawer, has come at a cost of reduced efficiency gains. This resulted in ARM's big.LITTLE strategy that combines smaller, more power-efficient cores with faster, thirstier cores to split the workload more efficiently.

Huawei's Mate 8 phone, one of the first to run a Cortex A72 chip.

Improving power management has been ARM's focus on the A73. One of the key tricks in the new core is its ability to handle performance demand peaks without substantially raising its heat output. It also appears that ARM will push a six-core A73 design with two A73 cores plus four A53 cores. This hexa-core design reportedly has the same physical size as an eight-core Cortex A53 chip, but with up to 90% faster single-thread performance.

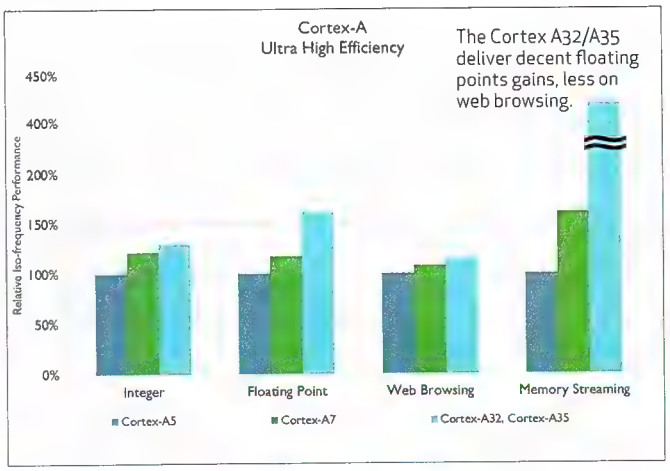

ARM
Cortex®-A32
The Cortex A32 core for Internet of Things devices supports 32-bit only.
ARM CoreSight™ Multicore Debug and Trace
Core 1
ARMv8-A 32b CPU
NEON™ SIMD engine
Floating Point Unit
8-64k I-Cache optional parity
8-64k D-Cache optional ECC
Shared L2 cache (128kB–1MB) optional ECC
128b AMBA®4 ACE or AMBA5 CHI or AXI4 Interfaces


ARM
Cortex®-A35
The Cortex A35 replaces the A7 with greater efficiency and 64-bit computing.
ARM CoreSight™ Multicore Debug and Trace
Core 1
ARMv8-A 32b/64b CPU
NEON™ SIMD engine
Floating Point Unit
8-64k I-Cache optional parity
8-64k D-Cache optional ECC
ACP
SCU
Shared L2 cache (128kB–1MB) optional ECC
128b AMBA®4 ACE or AMBA5 CHI or AXI4 Interfaces


ARM
Cortex®-A73
The new Cortex A73 improves power management, peak clock at 2.8GHz.
ARM CoreSight™ Multicore Debug and Trace
Core 1
NEON™ SIMD engine
Floating Point Unit
Shared L2 Cache (256kB–8MB) Optional ECC
128-bit AMBA®4 AXI4 or ACE

A New Premium Mobile Experience
1.5x
Performance compared to 2016 devices
Compute and graphics performance for the latest and the most demanding use cases

The Cortex A73 and Mali-G71, ARM's top-drawer cores for 2017.



ULTRA-EFFICIENT CORTEX A35

In similar fashion to how Intel splits its Atom, Pentium and Core i-series processors, ARM also has three mobile CPU families on the go. Its top-drawer 64-bit 'premium performance' range is built on the Cortex A72 and A57 – its 64-bit mainstream 'high-efficiency' series comes from the Cortex A53. But until recently, ARM didn't have a 64-bit core to replace the ageing Cortex A5 and A7 designs for the ultra-low-power market. Well, ARM talks up the A53 as a replacement for the A7. But it turns out the A53 draws more power than the A7, despite significant performance gains, so as a replacement for the A7, the A53 is, but isn't.

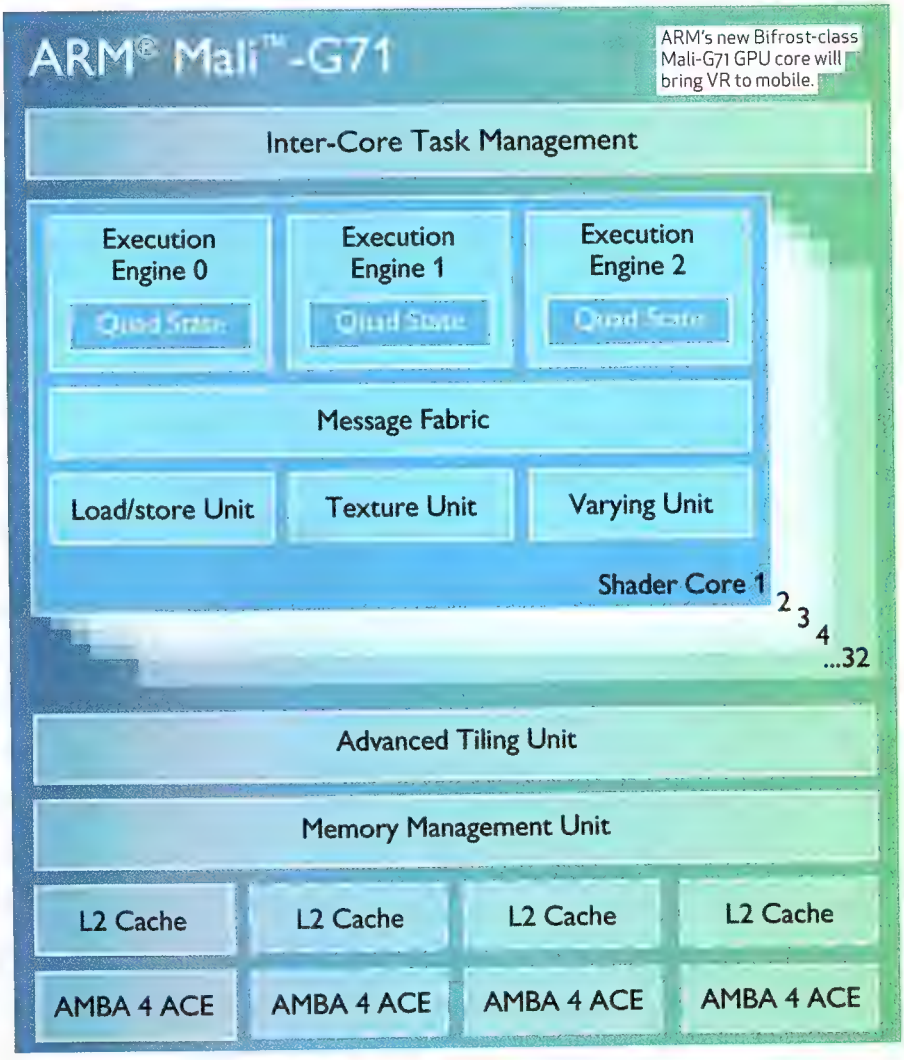
This became much clearer when ARM announced earlier this year its intentions to plug this gap with the new Cortex A35 (**tinyurl.com/apc431a35**). According to figures flying around the web, an A35 core consumes just 90 milliwatts of power at a 1GHz clock speed on a 28nm scale, which is up to 32% less power than required by the A53. Compared with the old Cortex A7, the A35 will be up to 40% faster. And it's 64-bit.

What's clever about the A35 design is that it's also highly configurable – you can have single, dual or quad-core designs with amounts of L2 cache from 128KB up to 1MB.

However, this also means the performance range available from Cortex A35-powered devices could be immense, depending on the number of cores and L2 cache packed in. But specs alone won't be enough to tell A35-powered devices apart – you'll need benchmark tests to know performance levels for certain.

IOT GETS CORTEX A32

Meanwhile, the Internet of Things (IoT) has created a love-hate relationship with the technology fraternity – some think it's the future, others a waste of time. So far, the majority of IoT development has been based around Cortex M-series microcontrollers, low-power CPUs typically used in minimal- or single-function devices like fitness bands. But ARM is giving IoT some Cortex A-series support with the new Cortex A32 (**tinyurl.com/apc431a32**). It's essentially an A35 core with 10% improved efficiency but no 64-bit architecture. It can be built into quad-core configurations up to 1GHz and is designed to power next-gen fitness bands and wearables. These devices usually run limited OSs such as Android Gear, but the A32 is also able to run full-function OSs from Android to Microsoft Windows. It'll be coupled with a new GPU, the Mali-470, designed for displays up to 640 x 640 pixels and requires only half the electrical power of the original Mali-400.



NEW GPU – THE MALI-G71

And to top it all off, ARM also announced a new GPU core, the Mali-G71 (**tinyurl.com/apc431g71**).

It picks up where 2015's gold-plated Mali-T880 leaves off, with 40% better performance and 20% better energy efficiency, due to its brand-new 'Bifrost' architecture. Bifrost looks the real deal – it features "full hardware coherency", which is another way of saying it takes the GPU from 'also-ran' to 'co-captain' status with the CPU, by allowing the GPU to share cache memory with the CPU. This is massive because it means GPU code won't need a full RAM call to grab data if it's already available in the cache. Even better, the whole thing has been designed with Android in mind, with efficient drivers that play nicely together. The G71 also supports DirectX 12, as well as Khronos' Vulkan open-source graphics API.

Even the applications ARM is pitching the Mali-G71 at tell us plenty about the future of mobile graphics – UHD content and mobile VR. Virtual reality was a key theme at the recent Computex tradeshow in Taiwan and it'll be no surprise that mobile VR becomes a major selling point in 2017's mobile market. Throw in 4K smartphone display panels and the G71's performance will be timely.

Its scalability is damn impressive, too – G71 designs can span from one to 32 cores, twice as many as the Mali-T880. It'll also deliver 120Hz refresh rate support, so the level of gaming you see from next-gen devices should be impressive.

WHAT'S COMING WHEN?

As for when you'll see these goodies arriving in new mainstream devices near you, things are a little more complicated. Unlike AMD and Intel, ARM doesn't make chips, it licenses its chip designs to other companies, around 250 of them at last count, to build their own smartphone-capable SoCs (System on a Chip). But there are a handful of brands also with 'architecture licenses' that give the holder rights to incorporate ARM's instruction set into their own custom core designs.

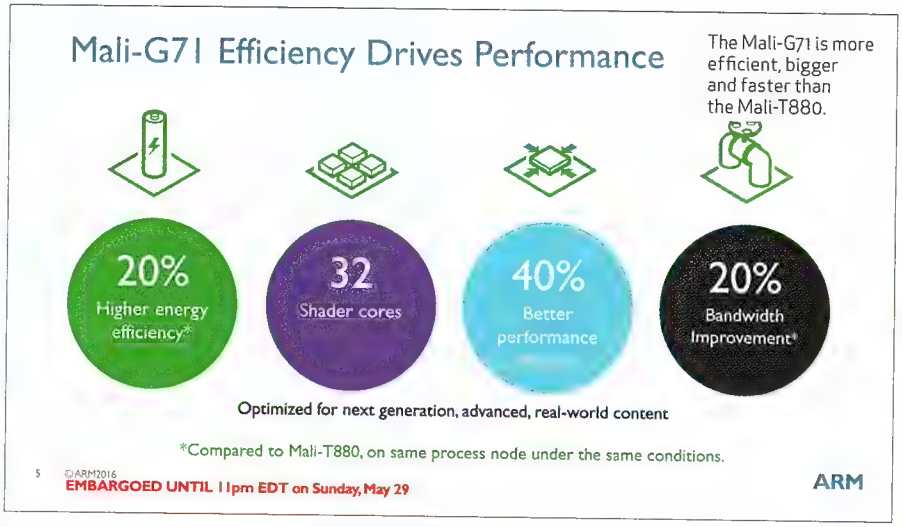
Qualcomm, for example, is now stamping out its own 64-bit Kryo core to follow up the popular 32-bit Krait core powering a swag of Snapdragon SoCs before that. Apple began producing its own designs with the Apple A6 SoC in the iPhone 5. Today's Apple A9 SoCs in the iPhone 6S series are built on ARM's 64-bit instruction set, but the CPU hardware itself is an all-Apple affair. And then there's Samsung with its new Exynos M1 twin-clock cores inside the Exynos 8890 SoC powering some of its Galaxy S7 and S7 Edge phones.

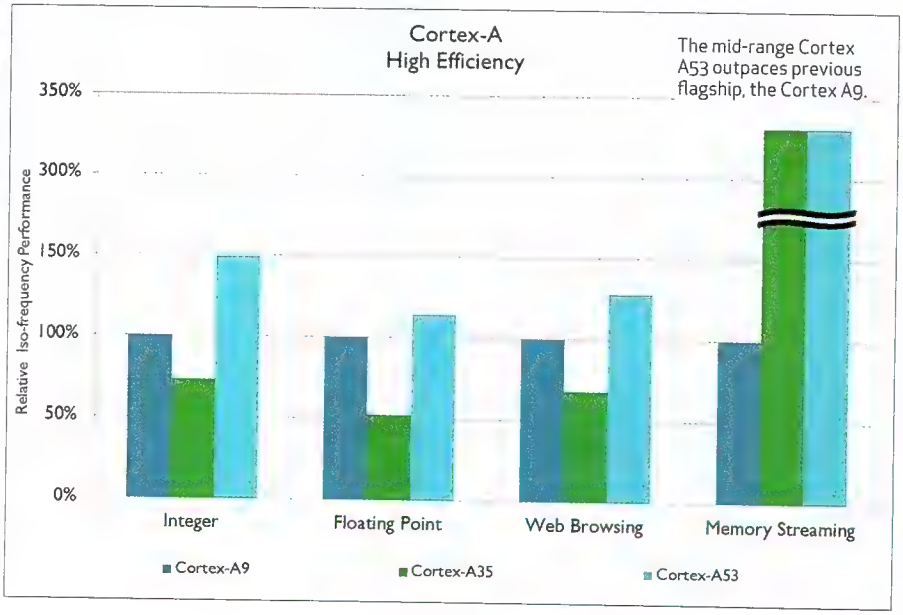
Samsung and Qualcomm still manufacture standard ARM-tech SoCs – Qualcomm started punching out new 28nm Snapdragon 650 (hexa-core) and 652 (octa-core) SoCs with A72 cores at the end of last year (the 652 runs Samsung's Galaxy A9). Samsung is also expected to release new Cortex A72-cored Exynos chips. In both cases, these will likely fill mid-range products only, as the custom SoCs await new flagship devices.

HiSilicon isn't widely known outside China, but Huawei's semiconductor arm already has Cortex A72 SoCs in the market – and manufactured at the smaller 16nm scale – called the Kirin 950 (2.3GHz) and 955 (2.5GHz). These are running inside Huawei's Mate 8 and P9 smartphones. Combining four Cortex A72 cores alongside four Cortex A53 cores, the Kirin 950-series are proving to be seriously potent performers. Among other chipmakers that appear to have their hands up for the A73 design are Marvell and MediaTek.

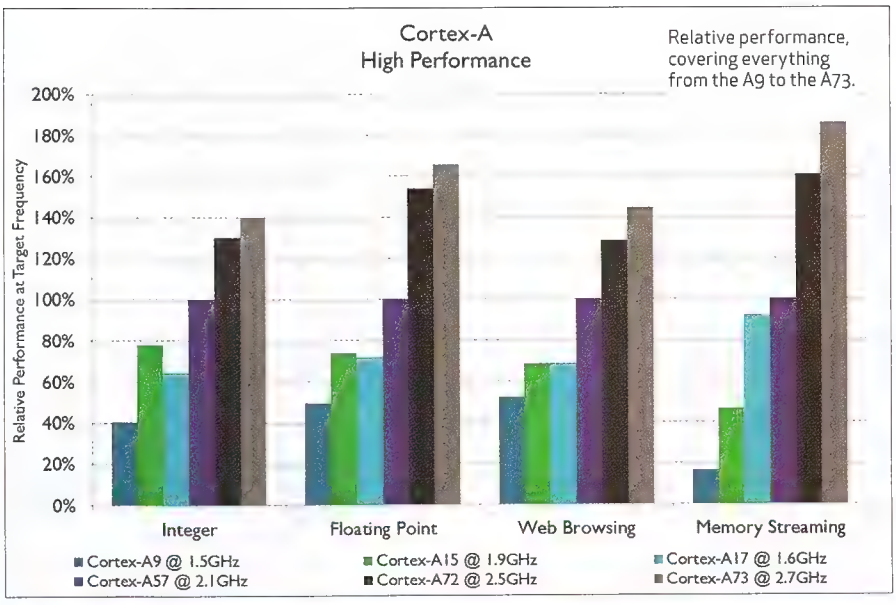
There are reports suggesting consumer devices with A73 cores could be available by Christmas this year, but we're not holding our breath – they might be available in small numbers, but we'll be surprised if they arrive in Australia before 2017. First cab off the rank could be HiSilicon's rumoured Kirin 960 SoC – it's expected to arrive in Huawei's Mate 9 later this year, but reports suggest it'll be a 16nm type.

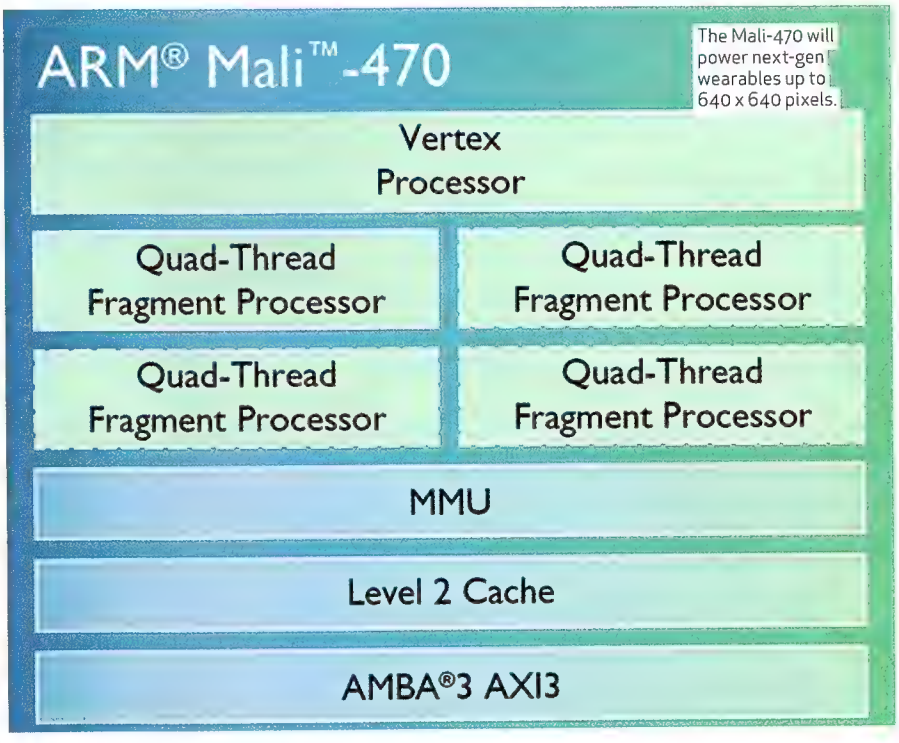
In the meantime, 2016 will see 16nm and 14nm Cortex A72 and A53 SoCs arriving in new devices. Word is Samsung's soon-to-be-released Galaxy C7 phone will pack in Qualcomm's Snapdragon 625 with eight 14nm Cortex A53 cores on-board. The last of Qualcomm's first-gen Kryo 100 custom designs, the Snapdragon 823, baked at 14nm, should be available by the time you read this. Second-gen Kryo 200 parts, the Snapdragon 828 dual and 830 quad-core models, will likely feature 1Gbps LTE (4G) modems and start sampling towards the end of 2016. Telstra and Optus are both talking 1Gbps 4G(X) data speeds for later this year, so the timing sounds about right.





Huawei's P9 smartphone runs a HiSilicon Kirin 950 Cortex A72 SoC.





BETTER BATTERY LIFE

But for most users, the bottom line will likely just be: 'Do I get better battery life?' The answer should be: 'Yes', but probably not as much as you'd expect.

The two key power drains on your mobile device's battery are the CPU and the screen. Research in 2013 from the University of New South Wales and NICTA conducted on Samsung's Galaxy S3 smartphone (**tinyurl.com/apc431unsw**, PDF) showed that, at idle (screen on, airplane mode, no app execution), the Galaxy S3 consumes 805 milliwatts of power. While the quad Cortex A9-cored Exynos 4412 SoC consumed around 130 milliwatts, the LCD panel chewed through a hefty 360 milliwatts.

Ultimately, lowering that 130mW SoC load with better design and greater efficiency is terrific, but when it's being swamped by the 360mW taken by the display panel, there's only so much that SoC optimisation can do. Now, granted, the S3 is pushing four years old, but nevertheless, the more you can lower that screen load, the more you'll see improved CPU efficiency having a positive effect on battery life.

TOP TIP: BUY LATE

With the rapid release of new Cortex designs, combined with a spate of new custom cores, not to mention four different manufacturing scales on offer (28, 16, 14 and 10 nanometres), picking processor performance is rapidly approaching lottery proportions.

While custom cores throw a spanner in the works, there is a simple rule of thumb for picking how Cortex SoCs will likely perform. If you want the fastest performance, go for the latest Cortex offerings – that's A35 in the ultra-low-power market, A53 in the mainstream and A73 in the premium class. But if you want maximum battery life, choose an SoC with the smallest manufacturing scale you can find – right now, that likely means 14/16nm SoCs as they come online this year and 10nm models next year. We'd expect 28nm scale manufacturing to fade into the background next year, as cores built at this scale will need to be clock-limited in order to achieve mobile thermal design power (TDP) ratings, limiting their performance by comparison.

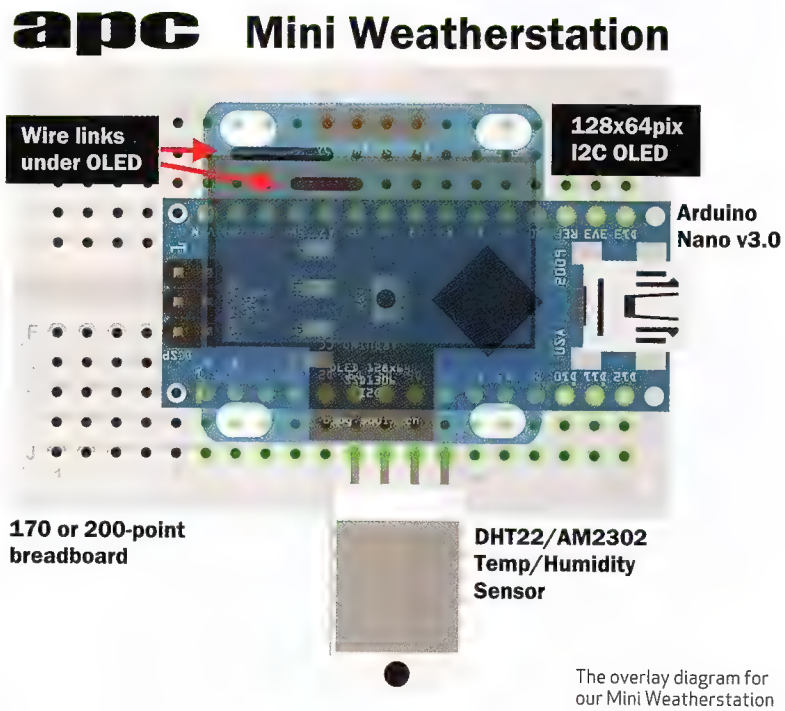
Things will also get interesting if chipmakers bring out older (and probably cheaper) core designs on smaller-scale processes, for example, Cortex A72 on 10nm versus A73 on 16nm or 28nm.

One thing's certain – levels of performance and battery life will both receive a decent nudge in the next 12 months. It's no wonder that 4K screens and mobile VR are on the menu next year!

Go organic with your Arduino

Shrinking your Arduino projects isn't difficult with plenty of cool options, including tiny breadboards and even smaller OLED display panels. Darren Yates explains how.

Arduino is a great platform for learning digital electronics and building your own tech. We've used the Arduino Uno for many projects and it's one of the most recognisable microcontroller board designs around. But to shrink your projects down, the tiny Arduino Nano is hard to beat. Featuring all the same tech as its larger sibling, the Nano is a 30-pin dual in-line package (DIP) module ideal for breadboards, even incredibly tiny breadboards. But it's the recent arrival of even smaller OLED display panels that can really spark up your projects.



The overlay diagram for our Mini Weatherstation — note the wire links.

WORLD'S SMALLEST WEATHERSTATION?

To show just how small and cool this tech is, we've combined them all to build what we think might be the world's smallest weatherstation display. All you need is an Arduino Nano, a 170-point breadboard, a 128 x 64-pixel I2C OLED panel, a DHT22 environment sensor, a 4-pin-tall female header, two wire links and our free source code. It looks simple, but it includes some old-school electronics tricks that cut down the component count. Here's how it works.

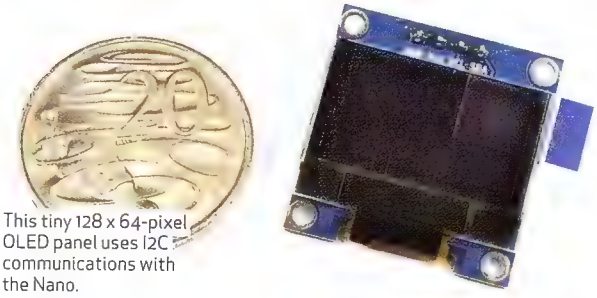
INTER-INTEGRATED CIRCUIT

The particular OLED panel we've chosen has just four connection pins and only two of these are needed for data. It uses a 35-year-old communications protocol developed by Philips Semiconductor called 'Inter-Integrated Circuit' or I2C. The Arduino Nano supports I2C on its analog pins A4 and A5. To light up, the OLED panel also needs 5VDC and 0V (ground) on its remaining two pins and this is where the first of our old-school tricks comes in. We've connected the OLED panel to the Nano's pins A4, A5, A6 and A7. However, A6 and A7 can only be used as analog inputs, and because they're inputs, they have a high resistance or 'high impedance'. This means we can get a little creative and re-route the 5V and GND pins to A6 and A7, respectively, using a couple of wire links and power the OLED panel. By doing this, we can add in a 4-pin-tall female header connector, plug in the OLED panel into the connector and lift it up and back over the Arduino Nano.

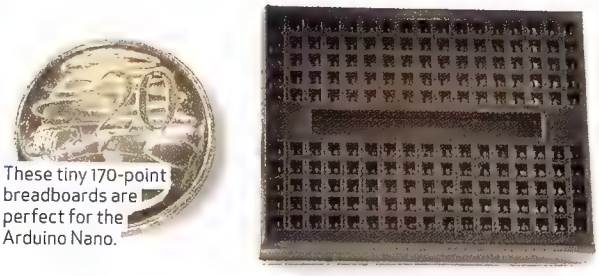
A couple of important tips — the OLED panel you buy should have only four pins, labelled GND, VCC, SCL and SDA. There are similar panels with seven connection pins — these use the Arduino's Serial Peripheral Interface (SPI) and they won't work in this configuration. Also, when buying the Arduino Nano, go for one that has the PC pins already soldered — otherwise, you'll have to break out a soldering iron and solder them in place yourself, which is a pain.

DHT22 SENSOR

To get temperature and humidity data, we pull in our old-favourite, the DHT22 environment sensor, which we've used on previous occasions. It's a four-pin device — two for power (5V and 0V), one for data and one that does absolutely nothing. The DHT22 needs power, but you'll see we've just plugged it straight

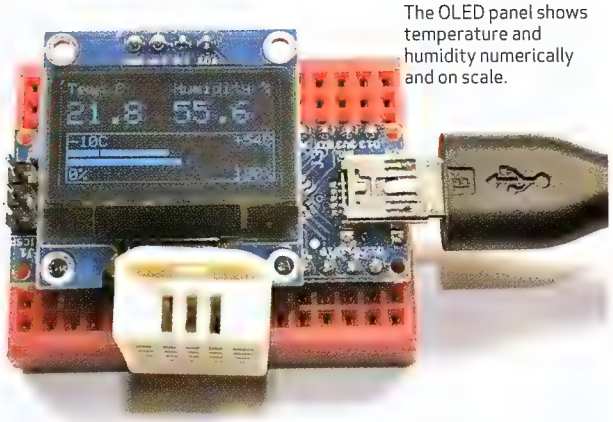


This tiny 128 x 64-pixel OLED panel uses I2C communications with the Nano.



These tiny 170-point breadboards are perfect for the Arduino Nano.

Our Mini Weatherstation packs in sensor, microcontroller and display panel.



The OLED panel shows temperature and humidity numerically and on scale.

into the Nano's digital I/O pins D3, D4, D5 and D6, and this time, we've used no wire links to route power in. Here's where our second old-school trick comes in. Because the DHT22 consumes no more than 3-milliamps (mA) of current, we can actually power it by turning digital pins D3 and D6 into power pins. All we do is code these pins as 'outputs', set D3 'high' to supply 5V and D6 'low' to acts as a pseudo-ground. The Arduino's digital pins can source or sink up to 40mA of current, so the 3mA of current the DHT22 needs presents no problem. By using this trick, we can simply plug the DHT22 sensor straight into the breadboard on the same pin rows as the Arduino Nano's D3, D4, D5, D6 pins and bingo – it's powered and off it goes.

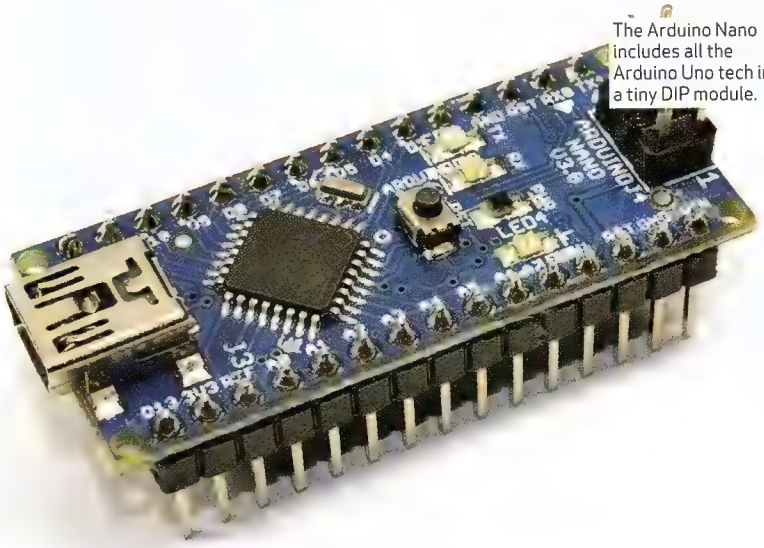
As a rule-of-thumb, using digital outputs as pseudo-power supply pins works provided the current you need is considerably less than the digital outputs can handle. In this case, 3mA is more than ten-times less than the digital output's 40mA limit, so we're sweet. Even better, by placing the DHT22 sensor on the breadboard edge, it acts as a wall for the OLED panel to lean against, stopping the panel's underside from shorting against the Arduino Nano.

170-POINT BREADBOARD

The whole project plugs into a tiny 170-point breadboard – they're brilliant and perfect for the Arduino Nano. These breadboards have 17 rows of ten pins split down the long axis into two separate groups. They come in a range of colours with a sticky backing to bind them to another surface. Use the overlay diagram to guide your build.

POWER REQUIREMENTS

If you own an OLED smartphone or TV, you'll know that OLED panels have brilliant viewing angles that leave LCD panels for dead. But there's an added benefit here – the 128 x 64-pixel panel we're using consumes no more than 40mA of current, total, with every pixel lit up. In normal operating, our whole Mini Weatherstation project draws no more than 40mA. All you need to do is plug in a MiniUSB cable between your PC and the Arduino Nano and up it comes.

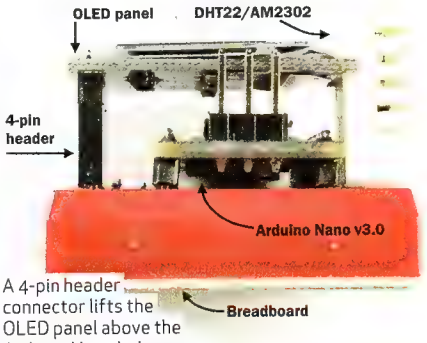


The Arduino Nano includes all the Arduino Uno tech in a tiny DIP module.

GET THE SOURCE CODE

You'll find the source code for this project at **apcmag.com/magstuff**. Download the zip file, unzip it and copy the contents of the libraries subfolder into the same of your Arduino IDE. Don't have the IDE? Get version 1.6.9 from **arduino.cc**.

Load the MiniWeatherstation.ino source code into the Arduino IDE, plug in your Arduino Nano, flash the source code and you're away. Look through the source code to learn how the SSD1306 OLED driver chip and DHT22 sensor work. Using the Adafruit_SSD1306 OLED and Adafruit_GFX libraries, commands to print text and draw graphics on the panel are easy to understand. It takes a bit more work, but we've even programmed the *APC* logo on the app's splash screen.

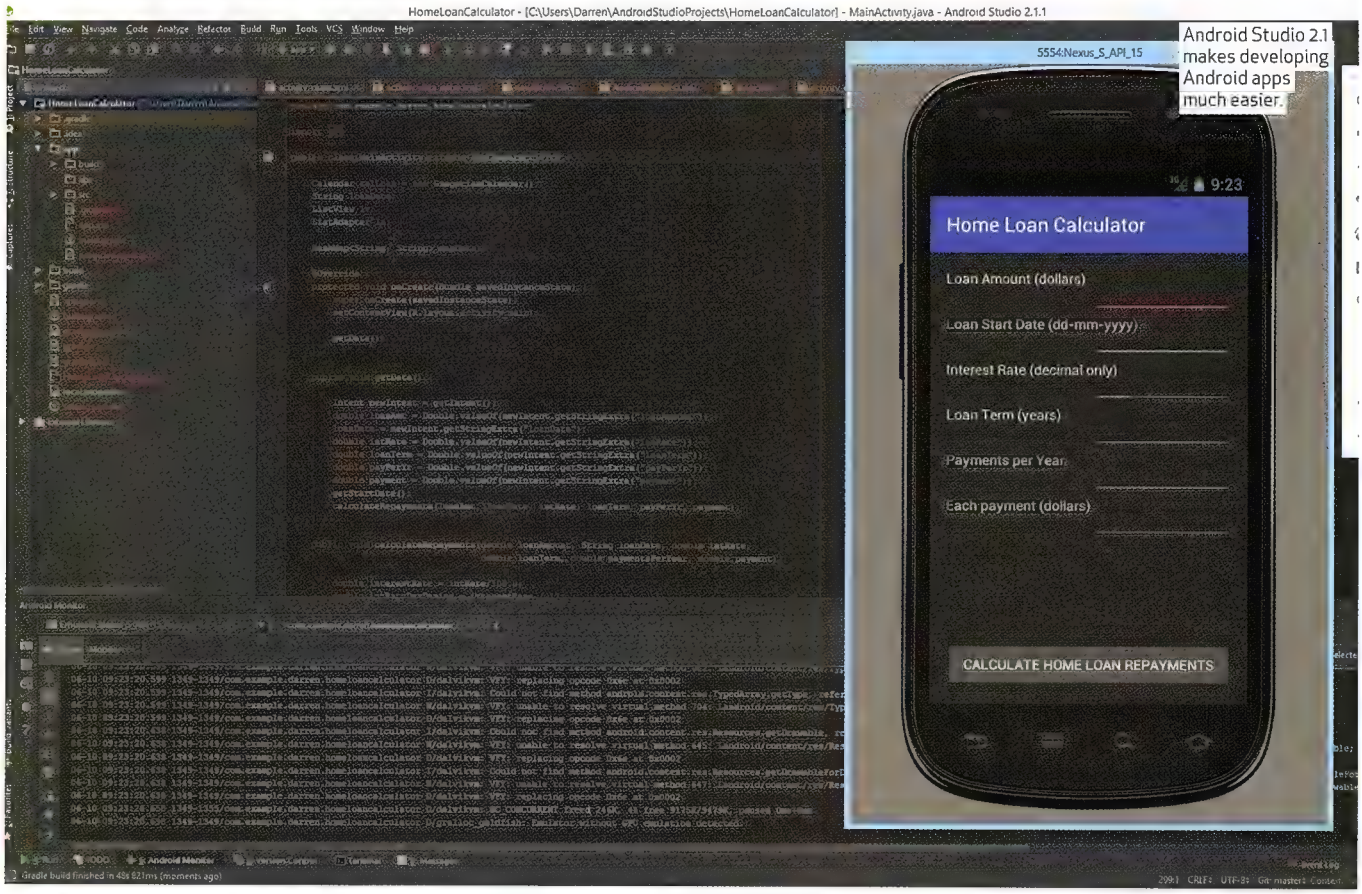


A 4-pin header connector lifts the OLED panel above the Arduino Nano below.

MAKE SOMETHING!

The Internet of Things craze is making electronics cool again and Arduino makes it easier than ever to build your own IoT devices and projects. Digital tech has plenty of answers for today's design problems, but there's plenty of scope for bringing back old-school electronics skills to make things smaller, simpler and easier.

So what are you waiting for? Get out there and building something!

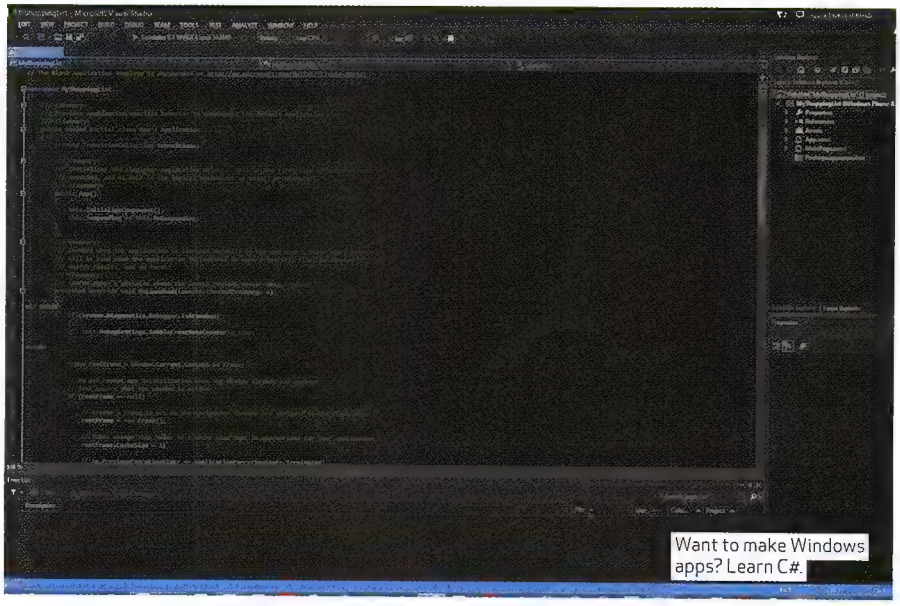


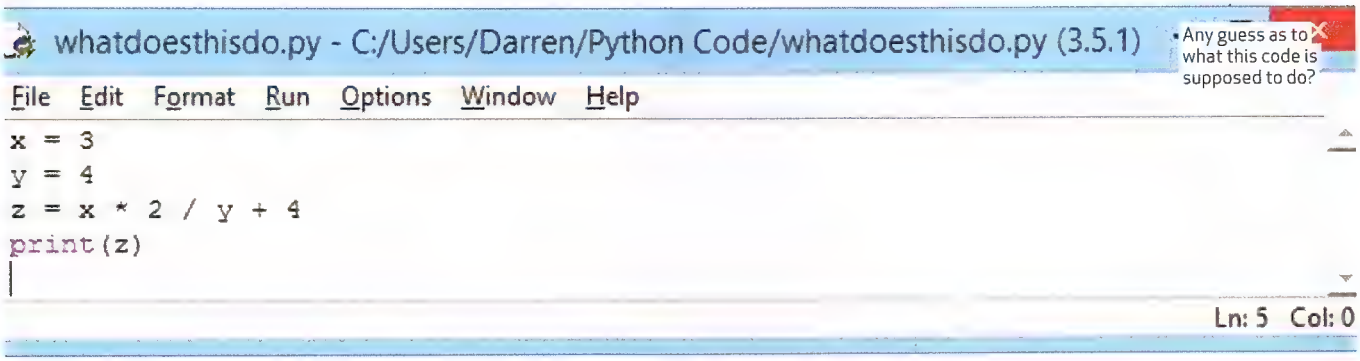
The 10 habits of highly effective coders

Being a great coder isn't always about what you know. Darren Yates looks at 10 habits that will improve your coding — whatever language you use.

Over the last couple of years, we've been systematically working our way through the nuts and bolts of the Java programming language, covering everything from variables to methods, inheritance to classes, threads to networking.

But while understanding how all of these techniques work is important, there are key lessons worth learning regardless of which programming language you take on. Everyone has different ideas on what makes a good coding habit, so we've come up with ten common tips handed out to coding beginners to get you going in the right direction. You don't have to agree with them, but they should get you thinking about how you write your code, not only for yourself, but for others to read and understand.




whatdoesthisdo.py - C:/Users/Darren/Python Code/whatdoesthisdo.py (3.5.1)
File Edit Format Run Options Window Help
x = 3
y = 4
z = x * 2 / y + 4
print(z)
Ln: 5 Col: 0

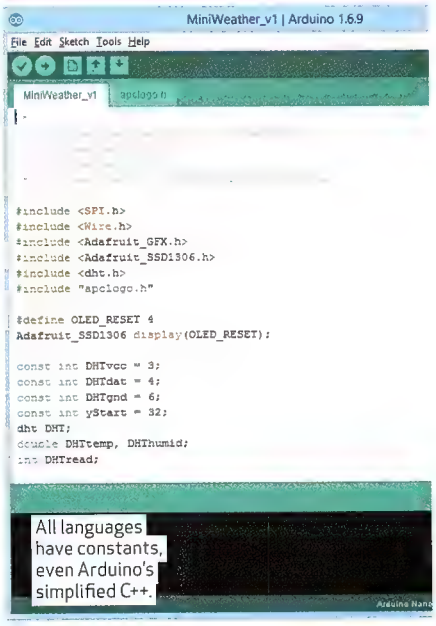
Any guess as to what this code is supposed to do?

```
while (currentLoanAmount > 0) {
    interestPaid = currentLoanAmount * (interestRate / paymentsPerYear);
    if (paymentPaid < currentLoanAmount) {
        principalPaid = paymentPaid - interestPaid;
    } else {
        paymentPaid = currentLoanAmount + interestPaid;
        principalPaid = currentLoanAmount;
    }
    totalInterestPaid += interestPaid;
    totalPayments += paymentPaid;
    currentLoanAmount -= principalPaid;
    totalPaymentNumber++;
    calLoan.add(Calendar.DATE,(int)(365/paymentsPerYear));
    paymentDate = calLoan.get(Calendar.DAY_OF_MONTH)+"-"+(calLoan.get(Calendar.MONTH)+1)+"-"+calLoan.get(Calendar.YEAR);
    dataModel.addRow(new Object[] {paymentDate, String.format("%.2f",paymentPaid), String.format("%.2f",interestPaid),
            String.format("%.2f",principalPaid), String.format("%.2f",currentLoanAmount)});
}
```

Always use human-friendly variable and method names in your code.

```
    @Override
    protected void paintComponent(Graphics g) {
        double radStart = 0.0;
        super.paintComponent(g);
        cloud = jpgCloud.getImage();
        g.drawImage(cloud,0,0,getWidth(),getHeight(),this);
        spit = pngSpit.getImage();
        for (Plane plane : planes) {
            plane.g2d = (Graphics2D)g.create();
            plane.g2d.rotate(rotatePlane(plane), plane.x+(plane.bwidth/2), plane.y+(plane.bheight/2));
            plane.g2d.drawImage(spit,(int)plane.x,(int)plane.y,(int)plane.bwidth,(int)plane.bheight,this);
            plane.g2d.dispose();
        }
    }
```

Consistent indenting of your code makes it much easier to follow.



WHITEBOARD BEFORE KEYBOARD

Imagine you've been given a coding problem to solve. What's the first thing you do – head to the whiteboard or head to the keyboard? In almost any problem, the last step you should do is the coding. There's actually a whole stream of study you can do called 'Systems Analysis and Design' that covers this problem defining and solving process. The first step (the 'analysis' bit) is working out the problem, understanding the needs of stakeholders and what the solution needs to do.

From a technical perspective, you need to understand the scope of the problem, understand any assumptions and error conditions you need to cover and what it will look like from the user's perspective. Once you've got that far, then you consider what the solution might look like (the 'design' bit). This often involves, again, consulting with stakeholders – the people who'll use your code – about what they need and want and how it will all work. When you've done all that, that's when you start coding.

When you've got code, you have to test it against your assumptions and error conditions, debugging any logic errors that turn up. Once it has been tested and meets all requirements, you get to deploy it.

Even if you're not writing code for a big corporation, the simple step of planning how your solution will work could save you huge amounts of time running around looking for unexpected errors later.

...BUT STILL CODE OFTEN

Now all that said, don't let that stop you from practising your skills. Coding is something you only get good at by doing it often. If you study for a university degree, lecturers will (hopefully) always tell you that it's much better to do a bit of study or practise each day, than try and cram everything into the last weekend before the exam. Why? Because your brain recalls processes better through repetition. Coding should be the same thing. Researchers say it takes about 10,000 hours to master an activity, so the more time you spend coding, the better you get at it.

You should still plan out your solution to any problem, even if you just nut out a rough idea in 'pseudo-code', plain-language code that walks you through what you want to do. But practising your coding, learning new skills, putting them into practice are the best ways to conquer coding. It's not unusual if you're a newbie to stare at a problem for a while, not quite knowing where to start and not wanting to make a mistake. Sometimes, you just have to start.

Of course, you'll make mistakes – we all do, but mistakes are not the end of the world. On the contrary, you generally learn far more from your mistakes than you do by getting it right the first time.

USE HUMAN-FRIENDLY VARIABLE NAMES

At the beginning, it can be extremely tempting to just use simple variable names like 'x' and 'y'. They're quick and easy and take few keystrokes. But what happens when you come back to your code later on, there are 5,000 lines of it and you have to try and figure out what 'x' does, or worse, figure out where the bug is.

This is why you should be somewhat verbose when it comes to variable names, method names and class names. For example, a method called 'calcIR' may mean something to you at the time if you know what 'IR' is, but 'calculateInterestRate' makes it bleedingly obvious. But so as to not make code lines too long, I try and aim

to limit names to no more than three words. Think about what the method or variable aims to do or store and write it down in three words. If it takes more than three words, chances are you might be trying to do too much and it could be worth splitting up that function. That's my take on it, but certainly, human-friendly variable and method names, in general, are a must. It may not be you who has to tweak your code at some point in the future and anyone who does will thank you for using human-friendly naming.

Use consistent naming conventions too, like camelCase for variables and methods and first-word capitalising names for classes – it'll make it much easier to follow the code later on.

INDENT YOUR CODE

All modern languages use code-block functions such as loops, if-statements and methods – functions that allow you to divide your code into manageable chunks or 'blocks'. But one way to make these functions far less workable is to muck up your indents. Unless you're working with Python, most languages don't require you to indent your code. But really, you're nuts if you don't. Most integrated development environments (IDEs) take care of this for you and automatically indent your code correctly. You should even be able set the length of the indent in the IDE options area.

The most important thing is to be consistent, especially when you have nested methods or statements. Consider a method with a for-loop and an if-statement inside the for-loop. Having those indented correctly means you'll be able to fly through that code and understand what's going on in an instant. It means having braces (the curly brackets that group code statements together) aligned so you can quickly see where code blocks start and finish.

Again, if you're working in a group, you need to just agree on the tab length, so everyone is on the same page. Two to four spaces is common – just pick one size and stick with it.

> "It may not be you who has to tweak your code at some point in the future and anyone who does will thank you for using human-friendly naming."

COMMENT YOUR CODE

Agile is a popular software development paradigm that aims, above all else, to be time-efficient. One of its most popular mantras is 'working software over comprehensive documentation' – the idea is to build working code rather than spend inordinate amounts of time creating letter-perfect documentation. It doesn't mean you ignore documenting your code completely, but you need to balance what you code and how you document it.

One of the simplest ways of documenting is commenting your code. All programming languages offer in-line code commenting (Java has three different options). You don't have to write a novel, but comments at the start of a class or a method at least will go a long way to quickly understanding what that code does. And if you're already using human-friendly method and variable names, along with consistent indenting, your code will be neat and everyone will love you for it.

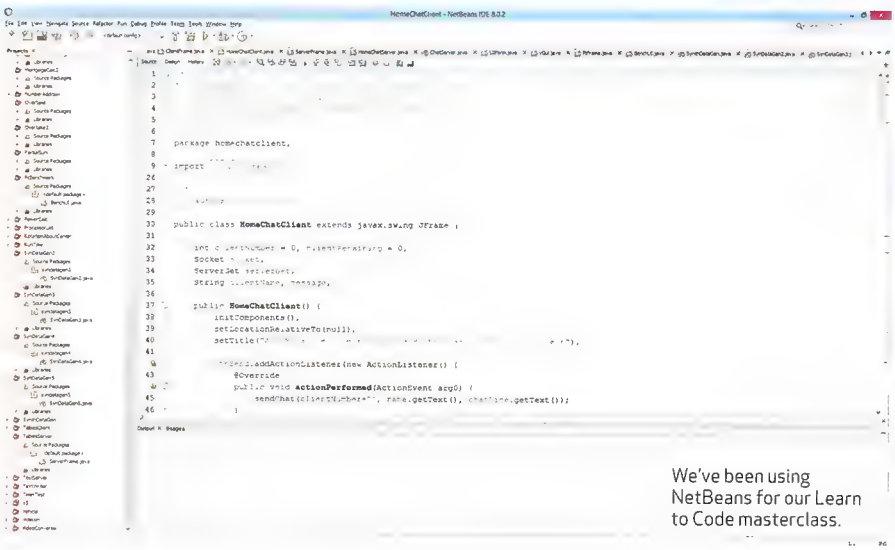
BE A LAZY CODER

By 'lazy', we don't mean leave it for everyone else to do, we mean don't have duplicate code. If you've been following our coding series for a while, you should be well aware of methods and classes. Make good use of them. Every time you code something, the chances are stacking up that you'll code a mistake. Code the same thing twice and you may as well put out an open invitation on Facebook for errors to turn up – not just wrong-spelling or 'syntax' errors, but logic errors, the type that are much harder to find. That's why you should always code once. If you need that code to run more than once, at least make it a method you can re-use within your class.

Code duplication will typically occur if you haven't fully planned out your code beforehand and you're coding on the fly. So again, it's important to plan before you code – it'll save you time and stress later on.

```
protected double rotatePlane (Plane plane) {
    double newRad = Math.atan((double)plane.dy/(double)plane.dx);
    if (plane.dx >= 0) newRad = (Math.PI * 0.5) + newRad;
    else if (plane.dx <= 0) newRad = (Math.PI * 1.5) + newRad;
    plane.newheading = newRad;
    plane = angleAddition(plane);
    return plane.heading;
}
```

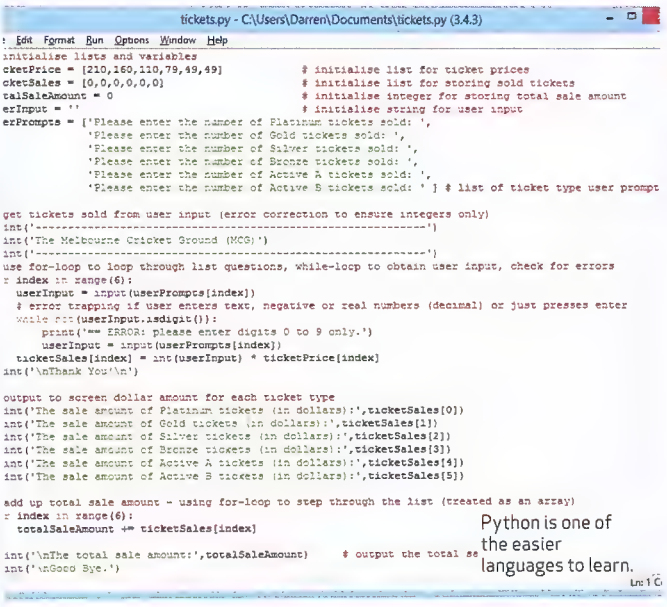
Be a lazy coder, use methods wherever possible and don't code twice.



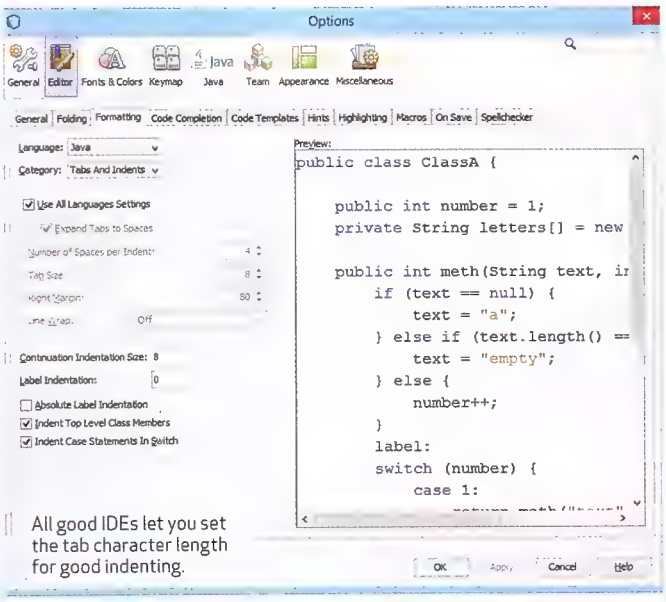
We've been using NetBeans for our Learn to Code masterclass.

WRITE CLEAN CODE

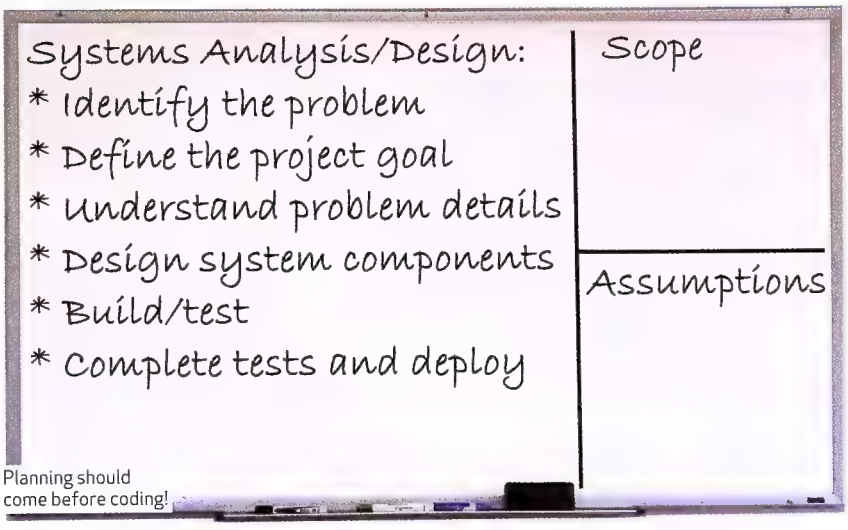
Consistent indenting, human-friendly variable names, commenting your code – they're all ways of helping you write clean code. Another one is don't have long lines of code. A simple rule of thumb is if your code line goes off the screen (or is longer than 80 characters), you either need to shorten the code or simply wrap the bit you can't see onto the next line. Languages like Java and C# allow this because the end of a code statement isn't a carriage-return but the semi-colon.


tickets.py - C:\Users\Darren\Documents\tickets.py (3.4.3)
Edit Format Run Options Window Help
initialise lists and variables
cketPrice = [210,160,110,79,49,49] # initialise list for ticket prices
cketSales = [0,0,0,0,0,0] # initialise list for storing sold tickets
talSaleAmount = 0 # initialise integer for storing total sale amount
erInput = '' # initialise string for user input
erPrompts = ['Please enter the number of Platinum tickets sold: ',
'Please enter the number of Gold tickets sold: ',
'Please enter the number of Silver tickets sold: ',
'Please enter the number of Bronze tickets sold: ',
'Please enter the number of Active A tickets sold: ',
'Please enter the number of Active B tickets sold: '] # list of ticket type user prompt
get tickets sold from user input (error correction to ensure integers only)
int('--')
int('The Melbourne Cricket Ground (MCG)')
int('--')
use for-loop to loop through list questions, while-locp to obtain user input, check for errors
r index in range(6):
userInput = input(userPrompts[index])
# error trapping if user enters text, negative or real numbers (decimal) or just presses enter
while not(userInput.isdigit()):
print('** ERROR: please enter digits 0 to 9 only.')
userInput = input(userPrompts[index])
ticketSales[index] = int(userInput) * ticketPrice[index]
int('\nThank You!\n')
output to screen dollar amount for each ticket type
int('The sale amount of Platinum tickets (in dollars):',ticketSales[0])
int('The sale amount of Gold tickets (in dollars):',ticketSales[1])
int('The sale amount of Silver tickets (in dollars):',ticketSales[2])
int('The sale amount of Bronze tickets (in dollars):',ticketSales[3])
int('The sale amount of Active A tickets (in dollars):',ticketSales[4])
int('The sale amount of Active B tickets (in dollars):',ticketSales[5])
add up total sale amount - using for-loop to step through the list (treated as an array)
r index in range(6):
totalSaleAmount += ticketSales[index]
int('\nThe total sale amount:',totalSaleAmount) # output the total sa
int('\nGood Bye.')
Ln: 1 Co

Python is one of the easier languages to learn.



All good IDEs let you set the tab character length for good indenting.



Planning should come before coding!

Clean code is code that's easy to comprehend, but it's more than just making it pretty to look at and nice to read. You could come up with a super-short, elegant solution to a problem, but the logic might be too convoluted to take in quickly. That will mean you take longer to understand how the code works. With tight deadlines, it may well be better to use common syntax and coding methods to make the code easier to understand.

AVOID THE USE OF MAGIC

Coding might seem a bit of a dark art at times, but really, it just follows logical processes. That said, you'll probably come across potions of magic in your own code, the most common being 'magic numbers'. These are integer or floating-point literals that appear in the middle of your source code with no reference to what they mean. For example, you've creating a for-loop and the end value is '54' – what does the '54' refer to? That's a bug waiting to happen. Instead, assign constants at the top of your class or method and use those throughout your code as necessary. This way, if that value needs to change, you change it in the one place, rather than have to follow the code logic to find out where else you've used that 'magic number'.

BE KIND TO FELLOW CODERS

No coder is perfect, no coder knows everything, there are always coders who know more than you do and coders who know less than you do. Stay humble and ask questions – that's the only way you'll ever learn.

In a very real sense, coding is as much a creative art as it is a science, which means everyone is going to have a different take on how something could be done. That's why if you're working in a team and it's important to have certain standards or conventions in your code, agree on those things at the start. But also be open to different ideas and ways of doing things.

If you need to criticise code, do it rarely, do it privately and if I can borrow a sporting analogy, play the ball, not the person. If you look at job ads for software engineers at Google, the search giant always wants people who will stand up for their ideas, but it won't be to the extent of pulling everyone else down around you. These are often the very same people you'll learn most from.

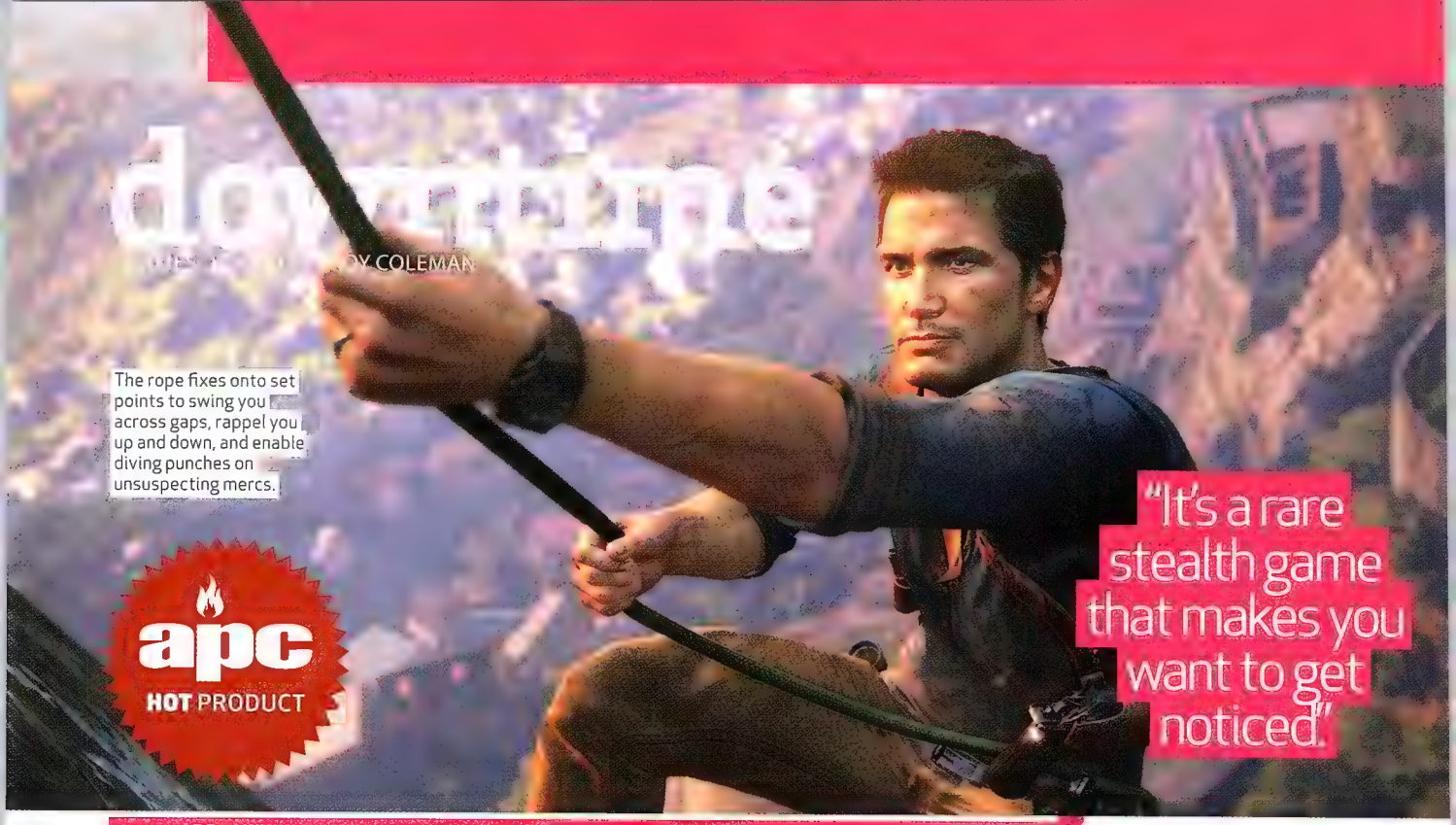
DON'T BE A ONE-HIT WONDER

Don't make the mistake that there is one programming language to rule them all and if you know that language, you're set for life. As many people before me have said, the only constant is change and it's so true of coding. That's why it's not only important to be exceptionally competent at your chosen language, but to also be aware of and at least conversant in a few others.

Different languages have different strengths – for example, Java gets you Android, while Python is popular in Data Science. Depending on the coding task required, your favourite language might work, but there could be an alternative language that already has all the tools ready to go, saving you reinventing the wheel.

Personally, I love Python's ability to return multiple values from a method and I love that it has libraries available for doing Data Science from scratch. For building Windows apps, C# is a no-brainer, while the open-source ecosystem for Java is just massive.

There is always the argument about specialising in one language versus being a 'jack of all trades, master of none', but locking yourself into one language in a world of constant change probably won't bode well for the future.


The rope fixes onto set points to swing you across gaps, rappel you up and down, and enable diving punches on unsuspecting mercs.
apc
HOT PRODUCT
"It's a rare stealth game that makes you want to get noticed."

$99.95 | PS4 | WWW.UNCHARTEDTHEGAME.COM

Uncharted 4: A Thief's End

The brothers Drake pick the pirate's life in PS4's most epic adventure.

Nathan Drake is a retired treasure hunter. By day, he scuba dives for a haulage company, plundering industrial junk instead of pirate gold. By night, he turns over legendary artefacts in his attic, and fires toy guns at hanging targets to substitute the thrill of adventure. He eats stir fry in front of the PlayStation with his wife Elena, who pokes him with a fork when she catches him drifting off to Shambhala in daydreams. He's moved on, done, domesticated. Until, that is, his long-lost brother arrives and proposes a daring mission that dusts off their ageing adrenaline glands.

So where's his brother been for numerous escapades across consoles and comics since 2007? Well, 15 years ago, something happened between the pair that Nate's been feeling pretty guilty about, and rather than mention the older sibling that taught him how to escape the nunnery he was confined to as a child by climbing over the rooftops, the brother who showed him how to sneak into stately homes and extract valuables, Nate instead suppressed all memory.

It's a very convenient explanation, sure, but Sam slots effortlessly into the *Uncharted* universe like he's been there all along. Their chemistry gives *A Thief's End* some of its brightest moments. "Did you take any pictures?" asks Sam of his younger brother's prior exploits. "No, but I drew sketches," says Nate. "What are you going to do with them, put 'em on your fridge?" teases Sam.

When the two meet for a heist with returning mentor Sully, a cigar-chomping mixture of Clark Gable and Burt Reynolds, it's the game at its playful best, tasking you with scaling the coastal cliffs of a luxurious villa as a pastel-coloured European town sparkles in the distance, then changing into tuxedos and mingling amongst Crudités-eating one-per-cent-ers, before strong-arming your way out, as so often happens to Drake.

PANAMA CAPERS

Good vibrations later are threatened by Nate's former partner-in-crime, now actual partner, Elena, who is reduced to a disapproving nag that hangs over parts of the game like a black cloud at a wedding. Thankfully, it doesn't stay like this for too long. In terms of tone, the second half doesn't quite hit the carefree highs of the first, which spans stormy glens, sunny archipelagos, and more locations too good to spoil.

It's no spoiler to say that every single scene is staggering, and worthy of spending hours snapping from every conceivable angle in camera mode. It's more than an artistic addition used to pan, zoom and focus; it's a tool that stops time to reveal developer Naughty Dog's craftsmanship, from the natural sunlight captured without cheesy lens flare, and the low-hanging clouds that cast shadows on the ground in slow-moving patches, and the seemingly infinite draw distance incorporating at points lavender-strewn moors and tropical gullies, to the subtle touches, like flecks of white in Nate's facial fuzz, or the way his grappling hook naturally wraps around objects rather than clipping through them.

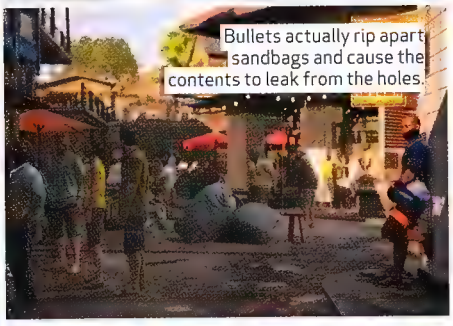
Set-pieces reach a series high – one involves a breathless car chase starting from the end of a rope dragging behind a mud-slick truck, and plenty more feature across rapidly crumbling architecture – *A Thief's End* is just as spectacular outside of them. To say Naughty Dog brings together the cinematic and the interactive doesn't quite do its job justice. It blends them seamlessly. There are no gamey healthbars or fade-to-black transitions between playable scenarios, and when the guiding hand does come in, like during an underwater escape as remnants from above cascade in bubbles around you, the camera merely centres in the right direction to suggest the route rather than wrestling control. Improved visuals and a greater sensation of influence as the player make this feel less restricted than past games while retaining filmic sensibilities.

GRAPPLING CROOK

There's more breathing room, too. One chapter sees you and Sam boat around the aqua-blue waters of an untouched

We took this shot ourselves using the class in-built camera. With filters, optical zoom, and depth-of-field effects, it's like having your own pro-tier SLR.

Aim flashlight beams at buddies' faces and watch them squint and recoil.


Bullets actually rip apart sandbags and cause the contents to leak from the holes.

Nate may be an old dog, but he's learned some new tricks.

archipelago and dropping anchor wherever you like. Spying a mast poking out of a coral reef in the distance, you can steer over and hop out, diving down through schools of dazzling fish to examine the centuries-old sunken wreck. Jewels you find and dialogue you discover aren't crucial to the story, but the choice of whether or not to pursue them is important.

These quiet bits are quite brave, too. The game sells itself on explosions and gunfights, yet you actually spend more time scaling Madagascan chapels and spelunking in forgotten caves to a soundtrack of echoes, birdsong and the occasional quip. Only Naughty Dog could make the act of finding a wooden bucket, lugging it to a pool, filling it up, then passing it up to your brother satisfying. Drake's grunts of effort as he bends down, the sloshing of the water in the container, the "Thanks, got it," as Sam takes the handle. Sections without incident allow the game's chest to expand with vital space. Sections with incident, then, are the short, sharp contractions in which all the air is squeezed out – often in a spectacularly violent expulsion.

Combat in Naughty Dog's previous game, *The Last Of Us*, was a tale of desperation and panic as you scampered around in shadows jury-rigging junk to stab people in their most delicate areas. If that was akin to an apology, this is a celebration. A rousing score frames your lemur-like leaping over numerous well-placed environmental footholds, your heroic swinging across ropes, and your Indiana Jones punch-ups.

They often start quietly, all about tracking enemies sneakily from waving long grass, rolling between crates and ammo boxes, and dropping onto enemies from above to snap their necks. With stealth meters and the ability to tag enemies, completing entire sections this way is finally feasible and earns a "Huh, they didn't notice us," from Nate. It's a rare stealth game that makes you want to get noticed, however, and as a testament to *Uncharted 4*'s shooting, you'll sometimes blast a poor fool in the face just to feel the kick of the satisfyingly meaty firearms and get the party started.

DRAKE AND DOSH

Stages are designed with Drake's climbing skills in mind, often craggy and hilly and filled with wooden overhangs to swing on. It's fun and frantic, more of an "Oh, crap!" to *The Last Of Us*'s despairing "Damn!" as you escape snipers' lasers by running to ravines and dropkicking foes en route, soar off and whip out your grappling hook at the last moment, and flatten the man below. It can feel a little too loose. Drake sliding over to fight goons several metres away or defying physics by changing his rope's swinging angle on a whim, giving the overall experience the sensation of twirling a gym ribbon: pretty but not entirely your own. What it loses in robustness, though, it gains in fluidity.

You'll clock the pattern early on – Quiet, quiet, bang! Quiet, quiet, bang! – but *Uncharted 4*'s brilliance is maintaining that tempo for 12 hours (more if you factor in multiplayer). You'll jet from locale to locale, platforming and fighting and charming across them with a vigour that belies Nate's accumulating paunch and crows feet. Age is a theme here, and obsession, and making a choice in what – or who – to pursue.

If it's to be his and Naughty Dog's final outing together, then what a way to go out. And if not, well, it's clear there's plenty of life in the old Drake yet. ■ **Ben Griffin**

Verdict

Whiteknuckle action, captivating characters and luscious locales — the best *Uncharted* yet.

★★★★★

Worst funfair ride ever.

NPCs like to mutter about how important it is to keep fighting.

Blowing up vehicles with this is pretty satisfying.

A silent first-person protagonist shooting flying drones, eh?

FROM $89 | PC, PS4, X1 | WWW.HOMEFRONT-GAME.COM

Homefront: The Revolution

A passable shooter that's far from revolutionary.

Homefront is a mash of the past 15 years of shooters, full of story contrivances and designs I've played and criticised before: the bad NPC chatter, the dystopian graffiti, the 'keep the tank safe' mission. It's not totally bungled — I had fun for the first half of the ten-hour-plus campaign — but there are a lot of crumbling buildings, uninteresting guns, and repeat objectives to put up with as your silent protagonist steals Philadelphia back from North Korean occupiers.

The open world is *Far Cry*-like, but less visually interesting and with no good reason to backtrack once the story has taken you to a new area. Whether in populated or off-limits zones, stealth is emphasised — the patrols are tough and big firefights lead to death — but I mostly just ran around a lot. I could've sneaked, or driven one of the overpowered, unsteerable motorcycles that get stuck in stuff, but neither of those options are very fun. So I just ran. I'd be detected by patrolling units — a few soldiers and an APC, often — but no one seemed to bother pursuing me.

If I died doing anything, it was never a big deal — all my progress toward my next objective was preserved. I appreciate that death wasn't frustratingly punishing, but in a better game, dying would teach me a lesson. Not so here, as there just aren't all that many ways to approach *Homefront*'s missions. Stealth is limited to throwing distractions and hiding, and the enemy AI can be overbearingly eagle-eyed or oblivious. Tools and guns meant to be cool just aren't useful. You can sneakily drive an RC car up to a patrol and detonate it, but in my experience, the dumb things just got stuck on rubble. I ended up using the same two boring, stock video-game guns — an SMG and marksman rifle — for most of the game.

And like the guns, the North Korean occupiers are stock enemies: communist baddies who come in basic infantry, sniper and heavy, bullet-sponge flavours. They run to cover, or at you, and fire, with no notable behaviours or abilities — though sometimes, you can kite them so they come at you one-by-one, down an alley or across a bridge between buildings.

The main activity, other than the story missions that have you meeting up with resistance fighters and getting them stuff, is capturing Strike Points, which act as safehouses and respawn points. I like these. They're pretty quick to do, and there's a good variety of simple platforming and combat challenges. Fighting random patrols is pointless, so Strike Points are also a chance to get in some shooting that matters, and that can be fun.

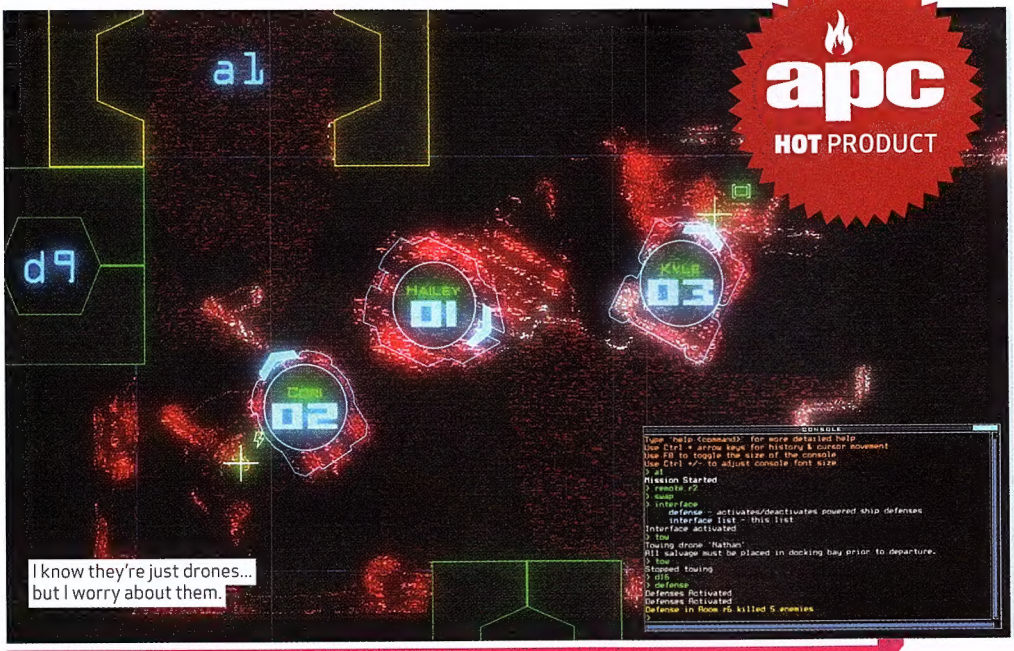
I had fun early on in *Homefront*, when I was experimenting with weapons and learning the tricks to breaking into safehouses. I got into a pleasant rhythm, ping-ponging between Strike Points on my way to the main missions, enjoying the satisfaction of accomplishing several small tasks in quick succession. But I never felt excited to see a new zone, and the story isn't riveting enough to accommodate hours of running past the same patrols without so much as a different-coloured landscape to look at.

With technical problems on top of that, I can't possibly recommend *Homefront* when there are so many better shooters like it. ■ **Tyler Wilde**

Verdict

It feels slapdash, and after the initial fun of learning its systems, drab repetition reveals obvious exploits.

★★★☆☆



apc HOT PRODUCT

US$20 | PC | WWW.DUSKERS.MISFITS-ATTIC.COM

Duskers

Explore edgy outer-space environs with your robot pals.

Something is chewing through a door on the derelict space station Volgograd. I've been exploring the station room-by-room for long minutes, with my fleet of drones, and so far, it's been a safe and worthwhile excursion. Now, though, I feel like I've overstayed my welcome. I quickly command my scouting drone to return to my docked dropship, but just as it speeds past the door that is being chewed through, I hear a loud beeping.

My console informs me that my second drone, which is powering a generator, is being damaged by another something that has crept through an air vent and spread across the room. I quickly drive the drone away from the new biological alien threat, which disconnects the power supply and means I can no longer remotely open and close doors in the station. My scouting drone is now trapped in the room, the one with the door that is about to give way to that something.

My third drone, at least, can manually pry open doors, but before I can dispatch it to save my first, I'm informed an asteroid shower is imminent. This leisurely and lucrative mission has, in the blink of an eye, become a panicky race against time.

This is the best part of *Duskers*, a survival strategy roguelike in which you pilot drones through procedurally generated derelict spaceships. It's perfectly fun and satisfying when things are going your way, but when the shit hits the airlock, *Duskers* really shines.

You begin with only a few days of fuel for your spaceship, three drones and the news that an undefined catastrophe has resulted in a post-apocalyptic universe in which you may be the only human survivor. You dock with other ships and send in drones to explore, scavenging for spare fuel, scrap metal and other drones to add to your fleet or turn into more scrap. You steer your drones one at a time using the arrow keys, and there's also a console to enter text commands.

Naturally, you're not alone. Enemies lurk unseen aboard the ships you visit. They might be automated ship defences, swarms of tiny robots or a horrifyingly fast-moving alien entity that will disable your drones in a split second. Ship airlocks and doors can be opened and closed using simple console commands, provided they are powered by a generator. It's a series of tense and spooky strategic challenges: keeping walls and closed doors between your drones and the enemies you've detected.

The game unfortunately suffers from the same problem many roguelikes do: your starting roll can often predetermine how much fun a particular session will be. Sometimes, you're saddled with drone modules you don't like, or the trading depots don't have the items you need or want. As a result, the occasional session can be a slow and disappointing slog with little chance of improvement or enjoyment.

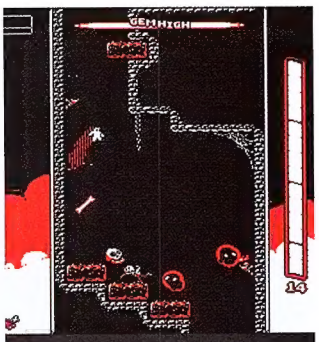
This doesn't stop *Duskers* from being a great game: challenging, always tense and completely startling at times.

■ Christopher Livingston

Verdict

A tense and spooky low-fi strategy game that is as satisfying as it is harrowing. Atmospheric sound design.

★★★★½



Downwell

If you want a thing done well...

US$2.99 | PC, PS4, PSVITA
DOWNWELLGAME.COM

You know how the famous nursery rhyme goes: Jack and Jill went up the hill to fetch a pail of water, Jack jumped in and caused a din by strapping on his gunboots and dropping through miles of the well's shaft, firing bullets from his feet to shred the well's critters as the stone walls of the cave reverberated from his laughter. A simple blend of gaming faves *Spelunky* and *Luftrausers*, *Downwell* is pure arcade heaven.

As you drop through a seemingly endless well that's teeming with bats, turtles and other beasties, your inputs are limited to moving left or right and firing your gunboots. Initially, a paltry eight-round pistol is all you've got, each shot not only harming enemies or blocks directly beneath you, but also acting as the only way of slowing your freefall. Your magazine automatically reloads when you touch down, but weapon upgrades and power-ups come thick and fast. A few levels in and you're lasering entire lines of blocks and baddies, automatically munching on corpses to top-up your health bar and firing bullets upwards every time you grab a gem. Progression through the procedurally generated levels unlocks snazzy filters, and in Tate mode, *Downwell*'s arcade offering becomes an utterly essential purchase.

■ Matthew Pellett

Tesla Model S can pretend to be a boat

Handy if you find yourself in deep water?

The Tesla Model S appears to have the ability to float "for short periods of time". Mid-June, a video was shared online, which apparently shows a Model S driving through a flooded tunnel in Kazakhstan. Though the water has stalled some vehicles, the Model S bobs in the metre-deep floodwater, then begins to weave through the other cars to safety using the wheels for thrust. As battery-powered cars have no exhaust pipes, there's no danger of them flooding in the same way; plus, the Model S possesses a bioweapon defence mode, aimed at purifying air within the cockpit – so you would assume the car would be properly sealed. While Elon Musk does not recommend you try to make the Model S float, an Easter egg in the car's software changes the picture of the car into the submersible Lotus Esprit from *The Spy Who Loved Me*...

Engage submarine mode, we're going under! Okay, James.

Large Hadron Collider brought to a standstill

AGAIN. THIS TIME, IT WAS THANKS TO A WEASEL.

You'd think the world's largest and most powerful particle accelerator would be a pretty strong piece of tech. Not so. It was broken by a piece of bread dropped from a suspected bird in 2009, and now it appears to have developed a malfunction thanks to a weasel. The Switzerland-based collider had been experiencing electrical problems and engineers eventually found a length of damaged power line that had been nibbled on by some kind of small mammal, leading to the largest machine in the world to be shut down. A hunt then commenced for the culprit, which turned out to be weasel that had sadly electrocuted itself by gnawing on a high-voltage cable. The following repairs were then extended due to other technical issues, which led the engineers to "check over the entire machine again".

Samsung copies not only Apple's designs

BUT NOW ITS SLOGANS AS WELL.

We would be surprised had you never seen a 'Shot on iPhone' poster — one of Apple's most successful advertising campaigns, which would feature either a shot from nature, a cityscape or of something relatively normal. In a recent Samsung video ad, in which the company demonstrates the crispness of the 4K video now available on its latest devices, the phrase 'Captured on Galaxy S7' appears pinned to the bottom right in a suspiciously similar fashion to the 'Shot on iPhone' campaign. But it's not just the phrase that has attracted criticism. The quality of the video appears too professional and impersonal, jarring with the 'You can do it, too!' mentality that the ads are supposed to be conveying.

LG launches mosquito-repelling TVs in India

LIFE'S GOOD, UNLESS YOU'RE A MOZZIE.

To combat the spread of dengue fever — spread by mosquitos that thrive and breed in stagnant water — LG has developed a model of TV designed to repel mosquitos, especially for its Indian customers. Dubbed the 'LG Mosquito Away TV' (catchy), it is "equipped with an ultrasonic device which, once activated, uses the soundwave technology and makes mosquitos fly away without emitting any harmful radiations". LG also claims that, since the technology doesn't use chemicals, customers don't need to worry about refills or wastage, and adds that the TV doesn't need to be on to work. While the technology isn't new — LG has already included it in a range of air conditioners — it will be interesting to see whether these products will have any sort of impact on the developing country.

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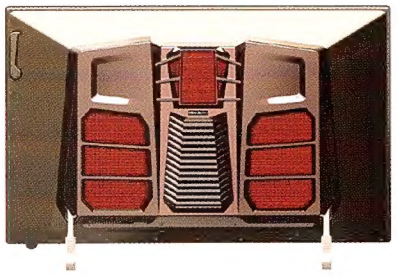

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